COMBERS AND COMBING

Combers and Combing

Their Setting and Principles of their Working

BY

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PREFACE.

THE object of the present volume is to supplement available literature relating to Combs and Combing, to give a general idea of the principles common to all types of combers and of the mechanism by means of which the operation of "tuft" combing is accomplished. The writer has found that, at least in some branches of the trade, combers and combing are mysteries only thoroughly or partially understood by a few. The result is excessive noil, breakages and undue wear and tear on the machine. To the uninitiated, the cycle of operations performed by the combing machine at high speed make it one of the most complicated of textile machines, while the exactitude of the setting required to attain the best results adds to the difficulty. Some existing literature only adds fresh difficulties, for when treating of machines of Continental origin a French or German description is often mis-translated. A typical example of this, and one which has caused difficulty to many, is the translation of the words *peigne alimentaire* by feed *comb* instead of feed *gill*. This organ of certain combers of the Heilmann type does no combing at all, its object being to control the delivery of fibres. In a similar manner certain authors only confuse the issue when they talk about "dabbers" in connection with the same type of combers. It is hoped, therefore, that this little work will help many who have felt themselves overwhelmed with the supposed complexity of the combing machine, and thus add to the knowledge of the art of combing to the mutual benefit both of the manufacturer and employee.

H. R. CARTER.

Belfast, 1914.

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INTRODUCTION.

COMBING is a process which is introduced into the spinning of the better qualities of yarn from various textile fibres. It provides a means of dealing more in detail with the fibres, of rejecting those which are less than the desired length and of clearing the fibre from impurities such as burrs, kemps, naps, nibs, shove, straw, &c., which remain after carding. The operation of combing has also the important result of placing the fibres in parallel order, in which state they produce a stronger and more lustrous thread.

The demand for better yarns is on the increase in almost every branch of the spinning industry, so that combing is likely to come more and more into vogue.

Combing machines have been classified into three broad divisions: (1) Tuft combs; (2) fringe tuft combs; (3) fringe combs. The Heilmann comb is a typical example of the tuft comb, the Lister comb of the fringe tuft comb, and the Noble comb of the fringe comb.

Combs of the Heilmann type are very suitable for cotton and when built on stronger lines for flax tow, ramie noils, silk noils, re-combing wool, &c. The Lister or nip comb is only suitable for the longest wool, for mohair and camel hair. The Noble comb stands alone for adaptability and cheap combing and is almost universally used in the worsted trade.

COMBERS AND COMBING.

CHAPTER I.

THE ORIGINAL HEILMANN COMBER.

THE root principle of all tuft combers is contained in the original invention of Josué Heilmann, of Mulhouse, Alsace, that principle being the combing first of one end of tuft of fibres, and then the other, and finally the laying of them slightly overlapping to form a sliver. In this operation each fibre is practically isolated and straightened out, in which condition it is afterwards maintained by the contiguity of the surrounding fibres.

Attempts made to construct short fibre combers on a different principle have been only moderately successful, and the Heilmann principle remains to-day the most approved for short fibres.

The Heilmann comb was introduced into Lancashire in 1850 and brought about quite a revolution in the production of fine yarn. By its aid 400's counts of cotton yarn became possible, or yarn measuring 191 miles per lb. avoirdupois.

The following is a description of the original Heilmann machine as given by the inventor, fig. 1 being a vertical section through the machine, and fig. 2 representing a feeding apparatus applicable to the machine. The machine, as illustrated, was intended for cotton combing. When wool or other material of longer fibre than cotton was to be acted upon, the machine was made upon a proportionately larger scale.

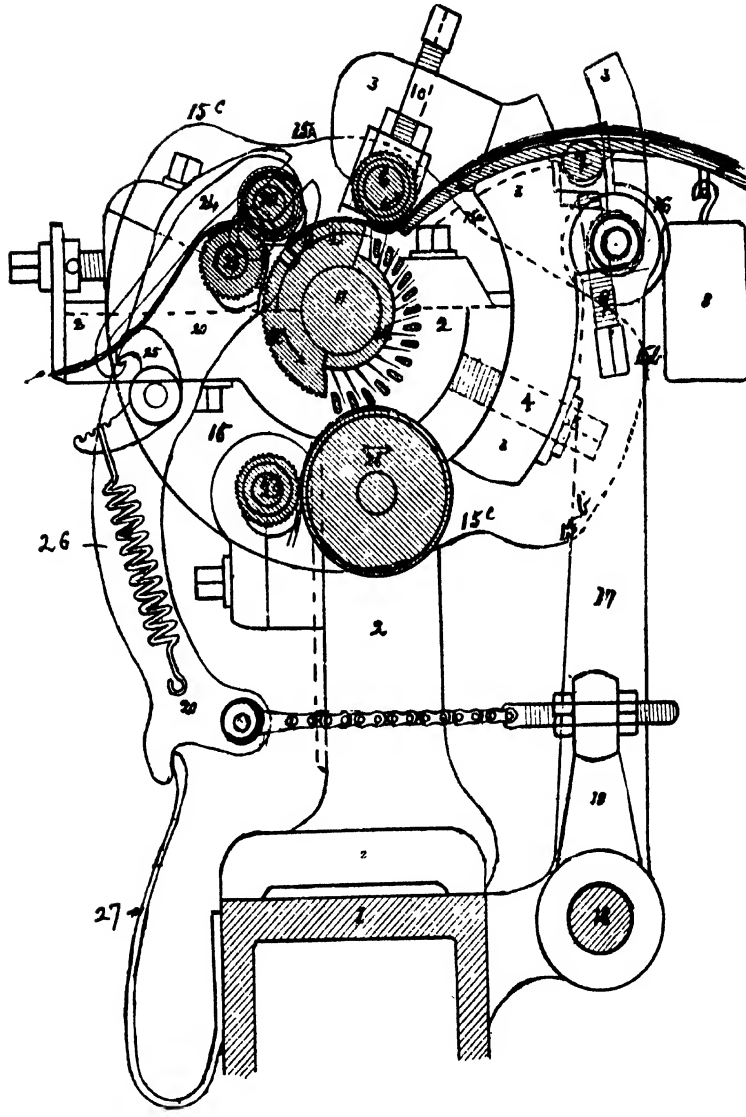


FIG. 1.

In fig. 1, 1 is a roller beam, 2 is a bearer, which carries the feeding, the combing and the drawing apparatus; 3 is a bearer for the feeding apparatus which has a vertical slot in it through which the screw 4 passes and secures it to the bearer 2. There is a concave curved surface on the inner side of the bearer 3, corresponding to a convex surface, against which it is screwed to enable it to be raised or lowered for the purpose of varying the distance between the rollers 6 and 22 to suit fibre of different lengths; 5 is a guide plate on which the cotton passes to the feed roller 6. The guide plate is supported on an axis 7. From one end of the guide plate is suspended a weight 8, which presses the fibre on the other end against the feed roller 6. That end of the guide plate which presses against the feed roller is covered with leather. The guide plate may be altered in its inclination by a screw 9. The feed roller is made to pass forward a portion of the fibres of cotton, and then to stop for a short time and hold that portion to be combed, and its action is thus regularly intermittent. For long fibres a bottom roller may be used in place of the guide plate; 10 is a screw by which the feed roller may be regulated in its distance from the combing roller 11. This roller is divided longitudinally into three parts, the part marked 12 is fluted, the part marked 13 is covered with leather, and the part marked 14 is furnished with gills, flanges, slots and bars, which bars take into eccentric grooves attached to the framing. On one end of the combing roller is fixed a tappet 15, which acts against a friction roller 16, working on a stud attached to the top of the lever 17. This lever at the lower end is keyed upon a shaft 18; upon this shaft is keyed a short lever 19, which is attached by a chain to the bent lever 20. This lever works upon an axis at 21 and carries a top roller 22, covered with leather, and the bottom fluted roller 23; 24 is a hook pressing on the axis of the top roller by means of the short bent lever 25 and the spiral spring 26,

both of which are attached to studs on the lever 20. A spring 27, fixed to the roller beam, presses against the lower end of the lever 20, and thereby keeps the friction roller 16 constantly against the tappet, so that part of the tappet marked 15*a* is acting against the friction roller; the top roller 22 is pressed against the fluted part 12 of the combing roller, by which it receives motion and at the same time draws the fibres from between the feeding roller and the guide plate and at the same time conveys them between itself and the bottom roller 23, which it turns by contact. When that part of the tappet marked 15*b* acts against the friction roller, the bottom roller 23 is pressed against the part 13 of the combing roller covered with leather, by which motion is imparted to it and the end of the lap of fibres is by this and the top roller passed back to be acted upon by the comb circle 14, during which time, by the action of that part of the tappet 15*c*, acting against the friction roller, the rollers 22 and 23 are stationary. When that part of the tappet marked 15*a*, is again acting against the friction roller, another short portion of the fibres which has been combed in front of the delivering roller and guide plate is drawn between the rollers 22 and 23 in the manner before described and overlaps the ends of the short portion of fibres previously drawn between those rollers, and as the drawing action of the rollers is greater than their backing action, a continuous sheet or sliver is thus formed in front of them. The burrs and other extraneous matter and the short fibres extracted by the comb were expelled from between its teeth by the bars between each row of pins, fell upon the surface of the roller 28, which was covered with leather, being by it carried and passed between that roller and the roller 29. The surface of the rollers 28 and 29 had a forward and backward revolving motion given to them, whereby they made the short fibres into a sheet or sliver. Heilmann drove these rollers in such a manner that they made about 6 in.

surface motion forward and 3 in. backwards for each revolution of the comb cylinder 11, preferring that the roller 28 should move in the same direction as the roller 11 when the latter was discharging the short fibres on to the roller 28. The roller 28 was driven by the surface contact of the roller 29, and the roller 29 by gearing not shown in the figure.

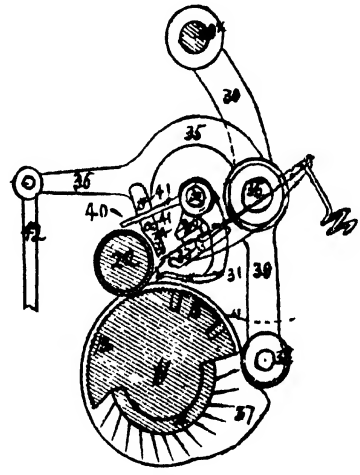


FIG. 2.

Fig. 2 represents, as we have said, the transverse section of another feeding apparatus applicable to the machine. The parts numbered 11, 12, 13, 14 and 22 and the mode in which they act have already been described with reference to fig. 1; 30 is a fixed bar provided with two rows of pins forming combs, into which the fleece is forced and by which it is held during the drawing action of the roller 22; 31 is a curved bar provided with a single row of pins forming a comb. This bar hinges about a fulcrum 32 and penetrates through the fleece from below; 33 is a flat bar, the lower edge of which is padded and

covered with leather. Opposite to it is another bar 34 fluted at the end next to the part covered with leather of the bar 33, and forming with it a pair of nippers. The bar 34 is connected to the lever 35, and vibrates from the movable fulcrum 36. There is a cam or tappet 37 fixed in one end of the roller 11, and this can act upon a roller 38 at the end of the lever 39, the fulcrum of which is at 39*x*. The small lever 40 is secured to the comb 31, and takes into space left between the two pins 41 fixed in the bar 34. The lever 35 is elevated and depressed by the action of the cam in connection with the rod 42.

The drawing represents the parts of this feeding apparatus in the positions they would relatively occupy when the combed part of the fleece is being drawn forward by the action of the top roller 22 against the fluted part 12 of the roller 11, and when another portion of the fleece is required to be combed, the cam 37 acts upon the roller 38 and moves the lever 39, which hinges with its fulcrum 39*x* and at the same time draws the nippers 33 and 34 in the direction from which the fleece enters. As soon as the roller 38 has been elevated to the extent of the cam 37, the nippers 33 and 34 are again closed by the action of the rod 42, so as to hold the fleece fast, and are then lowered so as to carry the portion of the fleece they hold to be combed, after which they are raised so as to convey the combed portion of the fleece under the drawing roller 22, as seen in the drawing.

CHAPTER II.

THE MODERN HEILMANN COMB FOR COTTON.

For many years Messrs. John Hetherington and Sons, of Manchester, enjoyed the monopoly of making this machine, and it may truthfully be said to have been

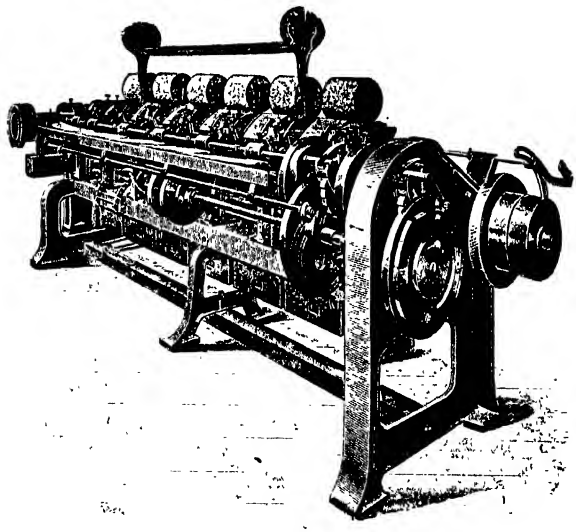


Fig. 3.

brought to its present state of perfection under their care, for no alteration in principle has been made since it was first constructed by them, and the details have only been slightly modified.

Fig. 3 gives a general view of a modern machine, which, it will be seen, is composed of several heads, 5, 6, 7, 8, or 10. Laps of sliver from the sliver lap machine or from a ribbon lap machine lie upon corrugated wooden rollers behind the comber, the laps being from 7½ in. to 12 in. wide. The feed is intermittent, and the length fed in each stroke is rather less than the length of the cotton staple.

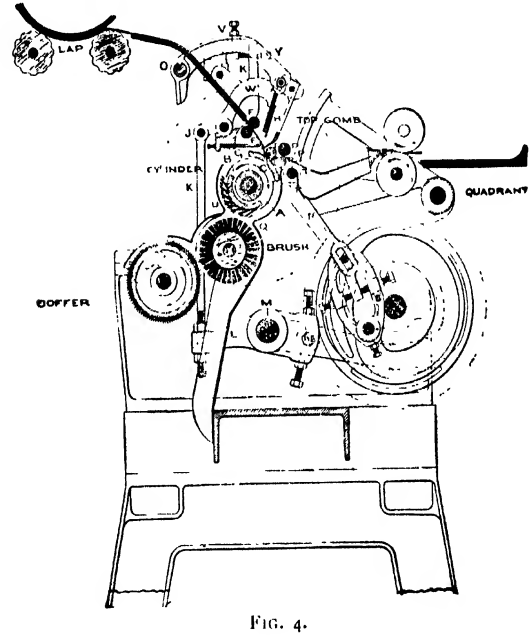


FIG. 4.

Fig. 4 shows a section of the single nip combing machine, as made by Messrs. Dobson and Barlow, Ltd. A is the comb cylinder shaft, CC is the fluted segment of the comb cylinder, DD are the fluted detaching rollers, E is the leather detaching roller, FF are the feed rollers, G is the cushion plate, H is the nipper knife, I is the nipper arm fulcrum, K is the upright connecting rod

for nipper arm, L is the nipper shaft lever, and M the nipper shaft.

The various combing actions of this machine will be easily followed by reference to the four following figures.

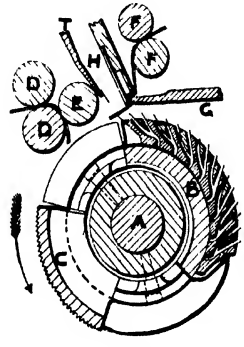


FIG. 4A.

In fig. 4A the feed rollers have passed forward through the nippers a suitable length of cotton, after which the nippers GH close, as shown in the sketch, and the needles

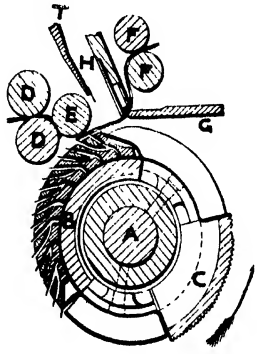


FIG. 4B

of the cylinder are upon the point of commencing to comb the fibres. This cylinder or comb segment is

composed of 17 rows of needles, evenly graduated, the first being coarsest, with stronger and longer needles, and the others gradually become finer and shorter until the last row. The object of this is for the coarser needles to open and prepare the cotton for each succeeding finer row, so that consequently the fibres are treated in such a manner as insures the maximum of cleaning with a perfect parallelism of the fibres.

In fig. 4B the completion of the combing action is shown, all the short fibres, nep, &c., having been taken out by the needles, which latter are cleaned by the

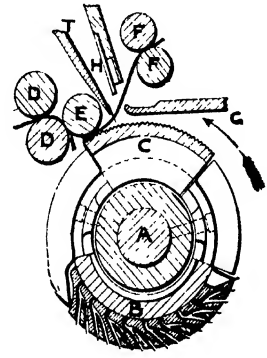


FIG. 4C.

circular brush seen in fig. 4. These short ends or waste are then taken off the brush by means of a toothed doffer shown, which in turn is stripped by a vibrating comb, the waste falling into a suitable receptacle placed to receive it.

Fig. 4C shows the overlapping process. The rollers D have been turned in a backward direction, and present a length of cotton ready for piecing. The roller E has been placed on the fluted segment, and naturally grips the end of the combed cotton, which, during its revolution, it carries forward and overlaps on the returned portion, so that an effective joining is the result. Just

before this action, however, the nipper is opened, and the top comb T comes down into the path of the lap, so that, as E carries the cotton forward, it is drawn through the needles of the top comb T, and properly treated.

Fig. 4D shows the finishing cycle of movements, E being on the point of being raised out of contact with the cylinder. The feed rollers FF have delivered cotton for the approaching combs, and the nipper is just about to close, after which follows a repetition of the actions already enumerated above.

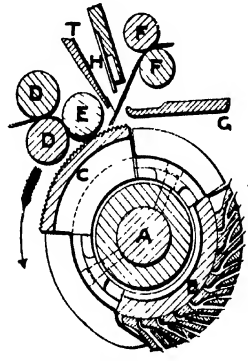


FIG. 4D.

It may here be remarked that the amount of cotton taken forward by the detaching roller is not equal to the amount combed, only the longest fibres being taken forward, so that the remaining fibres augmented by the fresh fibres fed by the feed rollers are again combed, and, in fact, all the fibres, before being absolutely free to pass forward, are combed several times.

The nipper of the Heilmann comb consists of two parts, a frame hinged on a pivot carrying the lower jaw or cushion plate, and normally supported by the pull of two powerful springs, and a second frame hinged on the first and carrying the upper jaw or nipper plate and

operated by a cam. The upper jaw is forced by the cam on to the lower one. The feeding of the material, the opening and closing of the nipper, and the raising and lowering of the top comb, and the operation of the detaching rollers are each worked by separate cams, which have to be individually adjusted relatively to each other.

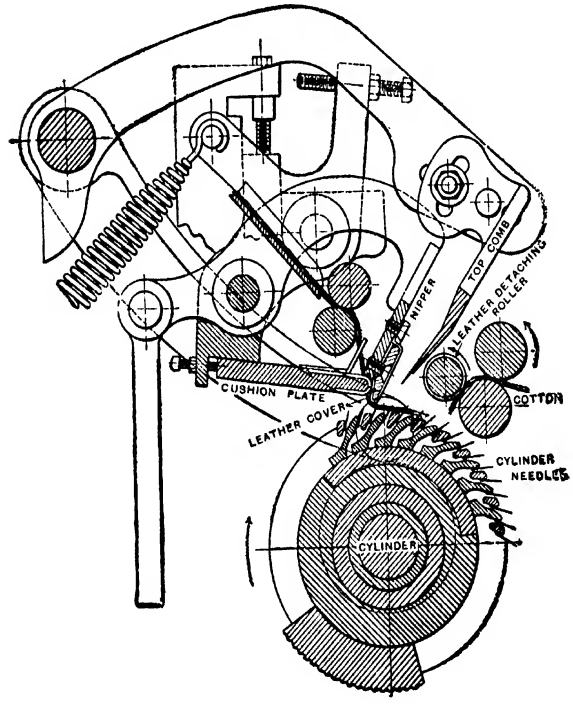
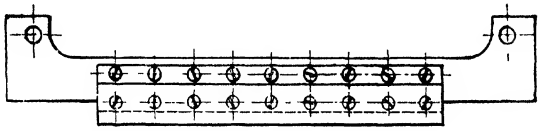


FIG. 5.

The nipper has no other function than to open and close to hold the fibre.

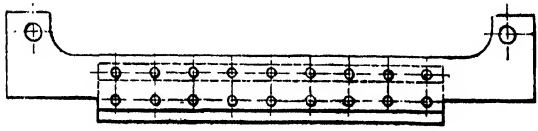
The construction of the nipper has been the subject of many patents. One of such patents is Ainsworth's, applied to the Heilmann comb by Messrs. Dobson and

Barlow, who claim that the production of the comb is thereby increased by from 30 to 60 per cent. It will be seen from figs. 5, 6, 7, 8, and 9 that this invention consists in the covering of the nipper knife in a particular



FRONT ELEVATION OF NEW NIPPER KNIFE

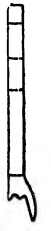
FIG. 6.



BACK ELEVATION OF NEW NIPPER KNIFE

FIG. 7.

manner with leather or other soft material. Fig. 5 shows a transverse section of the principal motions of the



OLD
NIPPER KNIFE

FIG. 8.

NEW
NIPPER KNIFE

FIG. 9.

machine, and figs. 6, 7, 8, and 9 are details of the parts affected. It will be seen from figs. 5 and 9 that the upper jaw or knife is enclosed in a covering of leather. The object of this covering is to enable the setting of

the nipper knife very close to the points of the pins on the comb circle, which was not possible with safety under the conditions hitherto.

By the use of this improved knife the productive power of the machine is increased, since a heavier lap may be penetrated and effectively combed owing to the fact that the needles of the circular comb enter the staple of the cotton at a point nearer to the nip than is possible when using the ordinary nipper.

The nippers are opened and shut by means of cams. The action of the latter should be smooth. They should be placed in the middle of short machines, and in, say, eight-headed machines, should be doubled, one cam being placed in the middle of each half of the machine, thus completely obviating any ill-effects arising from torsion in the shafts.

The raising of the cushion plate or lower nipper jaw raises the fibre into the top comb, through which the tail end is drawn by the drawing-off rollers. The top comb shaft should be strong, and a cam and lever placed at each end of it for working the comb.

The feed roller is either fluted or a porcupine roller, the object of the latter being to open the lap a little and prepare it for the pins of the comb circle. Intermittent motion is given to the feed rollers by means of a star or notch wheel, which should be of wrought iron, broad on the face, and case hardened to prevent rapid wear. The detaching rollers should be of cast steel, and the brass-top detaching rollers have wrought-iron case-hardened pivots working in brass levers, with wrought-iron links and studs case hardened.

The comb circle or cylinder has a needle segment containing usually seventeen strips or rows of pins, which are flat and soldered together, and to the strip on edge. The first row of needles is usually about 30 per inch, and the finishing row, say, 90 pins per inch.

The fixed or top comb has a single row of needles, set

to about the same fineness as the finishing row in the comb circle.

The headstock or gearing end should be built upon a solid cast-iron base-plate, and have two frame ends supporting a planed table, upon which the gearing is firmly secured, the whole being made extra strong and heavy to prevent vibration. The base of the machine should likewise be wide, with the same object. The gearing should be so arranged that every part can be easily removed without interfering with other parts.

The brush-driving arrangements should be so arranged that the brush may be driven at variable speeds as the bristles wear down; this arrangement preventing much loose fibre from flying about the room. The brushes may also be fitted with an oscillating motion to facilitate the cleaning of the comb. When Roth's patent aspirator is applied, the doffer and stripping comb are dispensed with, and the removal of the waste effected by means of a strong current of air. The arrangement of the combing cylinders and brushes remains as before, but the brushes are enclosed in casings which also extend partly round the combing cylinder of each head. These casings have communication with the cylindrical filtering screen, which extends the whole length of the machine, from the centre of which it has a communication with the forced draught apparatus.

In some machines the waste from the doffer falls up a a slowly moving shaft, which winds it into a lap. Another method is to have movable bobbins around which the lap is formed, each bobbin receiving the waste from two heads. Or sometimes a travelling lattice is placed at the back, on which the waste falls. This waste is afterwards made into a lap at the off-end of the machine.

Leaving the drawing-off rollers, the combed fleece passes along a trough or collecting tin and through a trumpet mouth to calender rollers which compresses it into sliver.

The patented stop motion, shown in fig. 10, may be applied to each sliver as it leaves the collecting tin, and is so arranged that when the thickness of the sliver becomes excessive or too light the machine is stopped. On a bar, having a knife-edge A, feelers or projections B, are placed, having trumpet eyes C, through which the

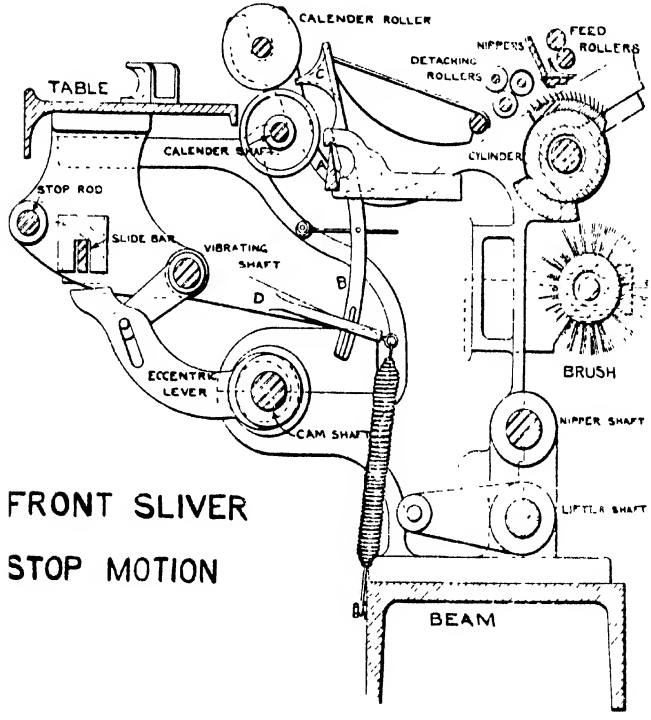


FIG. 10.

combed sliver is drawn. A breakage or failure in continuity of the sliver causes the stoppage of the machine by bringing the lower end of these feelers into contact with a vibrating striker or knocking-off arm D, so that the action of the machine is at once arrested.

Leaving the calender rollers, the slivers pass along a

sliver plate to the end of the machine, where there is a draw-box, in which the slivers from the several heads are doubled together, drawn out, and delivered into a coiler can as one sliver.

A row of stop-motion tumbler spoons is often placed immediately behind the draw-box to bring about the stoppage of the machine should a sliver fail. A full cam stop motion is usually applied also.

No textile machine requires more care and careful adjustment than the combing machine, for its successful working depends upon the proper setting and timing of the different motions. In the original Heilmann comb there were 564 parts in each set of six nippers. Setting them was a delicate operation, and its successful accomplishment required about 10 hours. In modern combers the number of parts has been greatly reduced, so that the nippers may now be set in half-an-hour.

Messrs. Dobson and Barlow advise the following methods of erecting, setting, and timing combers on the Heilmann principle:—

The machine should be put in place and levelled up, the top rollers sent to be covered, and the fluted rollers and segments scoured.

To set the cylinders, fit the latter in and set the index wheel to 5, and, with $1\frac{1}{8}$ in. gauge between the flutes of the detaching roller and the front edges of the segments, make the cylinders fast on their shaft, and then set the detaching roller flutes to 20 W.G. from the flutes on the segments.

The distance between the flutes of the detaching and feed rollers for Egyptian cotton should be $1\frac{3}{16}$ in., and for long Sea Islands cotton $2\frac{1}{16}$ in. The distance between the flutes of the detaching roller and the front edge of the cushion plate should be $1\frac{5}{16}$ in. for Egyptian cotton, and $1\frac{7}{16}$ in. for long Sea Islands.

To set the nippers, put on the cushion plates and set them up to one thickness of writing paper from the

nipper knife and to 1 $\frac{3}{16}$ in. gauge from the flutes of the detaching roller to the front edge of the cushion plate (the nippers must be open and the top screws about $\frac{1}{4}$ in. through); next set the edge of the knife to 20 W.G. from the cylinder needles with the right-hand screws only, and see that the distance between the detaching rollers and the cushion plate has not altered (a $\frac{5}{16}$ in. gauge must be between the point of top screw and the nipper stand); then set the left-hand screws by removing the gauge and letting the point of the screw touch the stand; then put on the springs. Move the cam round until the bowl is upon the circular part, and put the $\frac{5}{16}$ in. gauge again between the stop screw and the stand, then screw up the nuts on one connecting rod until the gauge is just eased. Now turn the cam round until the screw points are eased from the stands, then turn the cam back again as it was, and try your gauge between the knife and cylinder needles, and see that all are quite clear and to gauge.

Set the nippers to 19 W.G. to cylinder needles for Egyptian cotton, to 21 W.G. for Sea Islands, and set the top combs to 19 W.G. to cylinder segments for Egyptian cotton, and to 21 W.G. for Sea Islands cotton. Set the top combs at an angle of 28 degrees.

To set the feed rollers for Egyptian cotton, make the slides fast with 1 $\frac{3}{16}$ in. gauge between the flutes of the feed and detaching rollers, put on the top rollers and springs, and then set the rollers parallel to the nipper knife, and a convenient distance from it. For long Sea Islands cotton a 2 $\frac{1}{16}$ in. gauge must be used between the flutes of the feed and detaching rollers.

In setting the brushes let the bristles touch the brass of the combs of one cylinder, then make a gauge go between the brush and cylinder shafts, and set the others to this gauge.

The brush tins should be set about $\frac{1}{8}$ in. clear of the cylinder and doffer.

The lap plates should be set clear of the wood and feed rollers when the clearer brush is on.

The lap guides should be set $\frac{1}{4}$ in. wider than the laps, and central with the boss of the feed roller.

To set the top detaching rollers, move the wheel of 80 teeth on the cam shaft out of gear, and turn round the cam shaft until the quadrant moves forward. Then set the index wheel to 6, and put the wheel of 80 teeth above referred to into gear again. Turn the cam shaft round and see that the roller moves forward at 6. Then clean, oil, and put the steel tubes on the covered top rollers and put the rollers in. Weight the latter and let them rest upon the segments, bringing up the lifters until the nearest will admit one thickness of paper between it and the tubes. Then move the small slides on the lifters until each will admit one thickness of paper like the first one, and set the cam so that the roller will touch the segment at $6\frac{1}{2}$.

The fluted top detaching rollers should be set with the greatest care, so that the flutes are parallel in the flutes of the bottom roller, and quite clear from the leather roller when the latter is touching the segment.

For Egyptian cotton the top combs should be set to 19 W.G. from the segments of the cylinder, and to an angle of 28 degrees. For Sea Islands cotton the top combs should be set to 21 W.G. from the segments of the cylinder.

Since the action of a combing machine on the Heilmann principle depends entirely upon an intermittent action of the several parts, and each operation is so dependent on the other, the slightest variation from correct timing of the various motions destroys the efficiency of the machine. For Egyptian cotton, using the machine as made by Messrs. Dobson and Barlow, the clutch wheel should be in gear at $\frac{3}{4} = 3$ teeth of index wheel: the feed should take place at $5 = 20$ teeth on index wheel: the top comb should be down at $5\frac{1}{2} = 22$ teeth on index

wheel: the detaching roller should be forward at 6 = 24 teeth on index wheel: detachment should take place at $6\frac{1}{2}$ = 26 teeth on index wheel: the nip should take place at 9 = 36 teeth on index wheel.

The leather detaching roller must be lowered upon the flutes of the segment immediately the comb segment has passed, and must be raised again just when the pin points are almost in contact with it.

The amount of noil produced is increased by lowering the fixed comb, by bringing the cushion plate nearer to the comb circle, and by feeding late, or if the nipper is late in closing. The greater the angle of the combs, the greater the waste is also.

Curling is caused by the detaching roller being badly covered or badly lubricated, and by the top covered roller not touching the cylinder segment at the proper time.

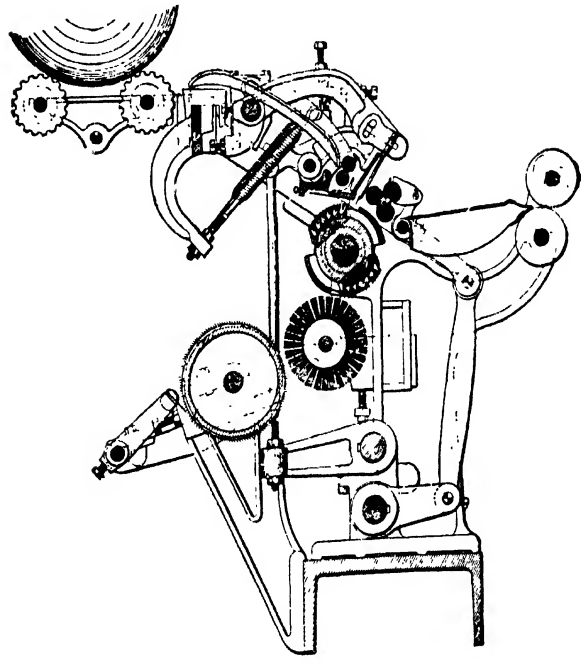
If the top fluted detaching roller be not set perfectly parallel with the flutes of the bottom roller, curling is also produced. The covered rollers should be varnished once a week. All the principal bearings should be oiled at least once a day, and the minor bearings every second day.

Well-constructed machines of this sort will run smoothly and steadily at speeds up to 95 nips per minute. They will comb anything from cotton of $\frac{7}{8}$ in. staple to silk noil of $2\frac{1}{2}$ in. staple without any changes except in the timing and setting of the machine.

The power required to drive them is approximately $\frac{1}{10}$th horse power per head. An eight-headed machine weighs about 2 tons, and occupies floor space approx. 18 ft. by 3 ft. 7 in. The production in lbs. of combed sliver per head and per 10 hours' day may be up to 13.

The desire to increase the limited production of the combing machine led to the introduction of several modifications of the original Heilmann machine. One of the most important of these is the duplex comber or double-nip machine.

Fig. 11 shows a section through the working parts of this machine as made by Messrs. John Hetherington and Sons, Ltd., Manchester. In the duplex machine all the principal parts act twice for each revolution of the comb cylinder. Instead of but one set of combs and one drawing-off segment, as in the ordinary machine, in



Section of Double Nip Comber.

FIG. 11.

the duplex machine there are two of each, the comb segments, however, having only 13 rows of needles, against 17 in the single-nip machine. In the duplex machine the cylinder turns more slowly, and the pins pass through the cotton at a slower rate of speed.

In the Hetherington duplex machine there are two detaching roller cams, the one cam making one stroke of the roller and its neighbour the next one. This organ has always been that which limited the speed of the machine owing to the great strain upon it. By doubling the cams the double-nip machine may easily make 130 strokes per minute, for, with the exception of the detaching roller, every organ of the machine is only making 65 revolutions or strokes per minute in place of 85 in the single-nip machine. The detaching roller, although making more strokes per minute, is moving slower when actually in motion in the double than in the single machine. The time is gained by the pauses between the strokes of the roller being of shorter duration. An increase in the diameter of the cylinder means an increased speed of the detaching roller and a quicker passage of the needles through the fibre. By this double cam arrangement there is ample time between the passages of the needles to make the piecing, and the comb cylinder need not be made any larger than in the single-nip machine. Were a larger comb circle necessary the speed of the needles through the fibre would be higher, the fibre would be more slayed, and more waste and inferior yarn produced.

Upwards of 50 per cent. more production can be obtained off this machine than off the single-nip machine.

CHAPTER III.

THE NASMITH COMBER.

A GREAT advance was made some years ago in combing-machine construction by the introduction of the Nasmith comber, which, without increase in speed, gives a much higher production than the Heilmann comber, and even when dealing with the shortest cotton produces only a reasonable amount of waste. The piecing it produces is also better than in the older machine, and the draw-box sliver consequently less cloudy. It differs from the ordinary Heilmann machine in that there is no leather covering required on the nipper. The machine also stands about 4 in. lower than the usual Heilmann machine, a great convenience for the tenter.

Fig. 12 shows a section through this Nasmith's patent comber, while figs. 13, 14, 15, and 16 show various details. Fig. 13 shows the crank M on the end of the cylinder shaft A for rocking the nipper shaft W. The peculiarity of this motion is the slow advance of the nipper towards the detaching rollers, allowing the maximum time for the detaching operation and the quick return. Figs. 14 and 15 are sections showing the parts at the close of the detaching periods and during combing respectively. Fig. 16 shows the details of the top comb, and figs. A, B, and C of fig. 17 show the position of the parts at various points of the stroke. The combing cylinder has 17 rows of needles, no fluted segment, and is completely enclosed.

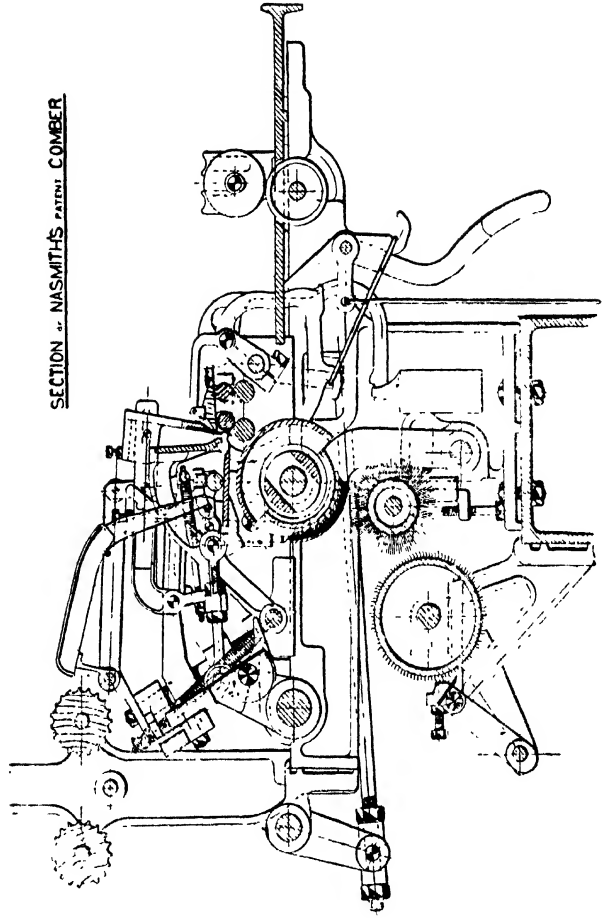


FIG. 12.

The nipper, driven by a crank, is self-contained, with fixed lower jaw that cannot touch the cylinder. It has, as we have said, no leather covering, closes gently without hammering, with little tension on the springs when opening, the weight coming on gradually as it closes. It swings on 1 in. studs 3 in. long, rocking in cast-iron bushes, and never requires re-setting.

The nipper shaft W (fig. 14) is rocked to and fro by a crank (fig. 13), and is connected to the nipper bridge S

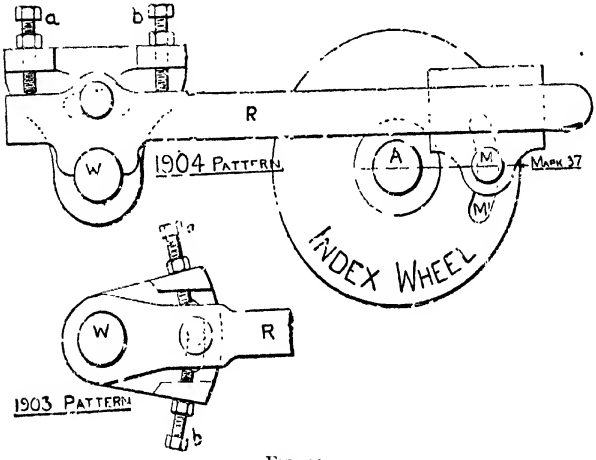


FIG. 13.

by the arms W^1 and connecting rods V (two to each nipper) with adjusting nuts V^1, so that the nipper jaws may be set parallel to and at the proper distance from the steel detaching roller D. Once all the nippers are correctly set, their distance from the roller D may be altered simultaneously by the screws *a* and *b* (fig. 13). The nipper bridge S is bolted at each end to an upright N secured to a stud N^1, which rocks in a bush carried in the framing. The top nipper arm pivots on studs P^1, carried in projections cast on the bridge S. At the lower

end of the arm a crossbar carries a bowl N^5, which comes in contact with the adjustable incline J, and opens the nipper as it moves forwards. When the nipper moves back for combing (fig. 15) this bowl leaves the incline J, and the nipper closes under the influence of springs attached to the lower end of the nipper arms. There is little pressure on the springs when the nipper is opening, but a strong pressure when closing during combing. The opening and closing thus takes place gently and without the detrimental hammering blow observable in some other combers. The nipper is adjustable to the needles by set screws T (fig. 15), and, once set, is a fixture, and cannot be made to touch the cylinder, as its path, if continued in both directions, never intersects the circumference of the cylinder.

Each nipper carries its own feed roller F (fig. 15), which is adjustable on the nipper plate, so that its distance from the jaw of the nipper is easily set to suit the length of the fibre being combed. The roller receives its rotation from the movement of the nipper through a ratchet and pawl. The roller turns inside a stationary bush, and the ratchet lever rocks on the outside of the bush, so there is no contact between the roller and ratchet except through the pawl, the whole being enclosed in a casing to exclude fluff and dust. There are no change wheels, the amount of feed being altered by the displacement of a stud.

Fig. 16 shows the disposition of the top comb C, which is bolted to the slot in the arms C^1. This slot and set screws C^5 permit an adjustment of the angle of the comb within the required limits. The arms C^1 are pivoted on the nipper frame at C^3, and consequently participate exactly in the reciprocating motion of the nipper. During combing the weight of the comb rests upon the set screws C^4, which regulate the depth of penetration of the comb. When the nipper goes back the bowl C^2 comes in contact with the adjustable bar I, and is

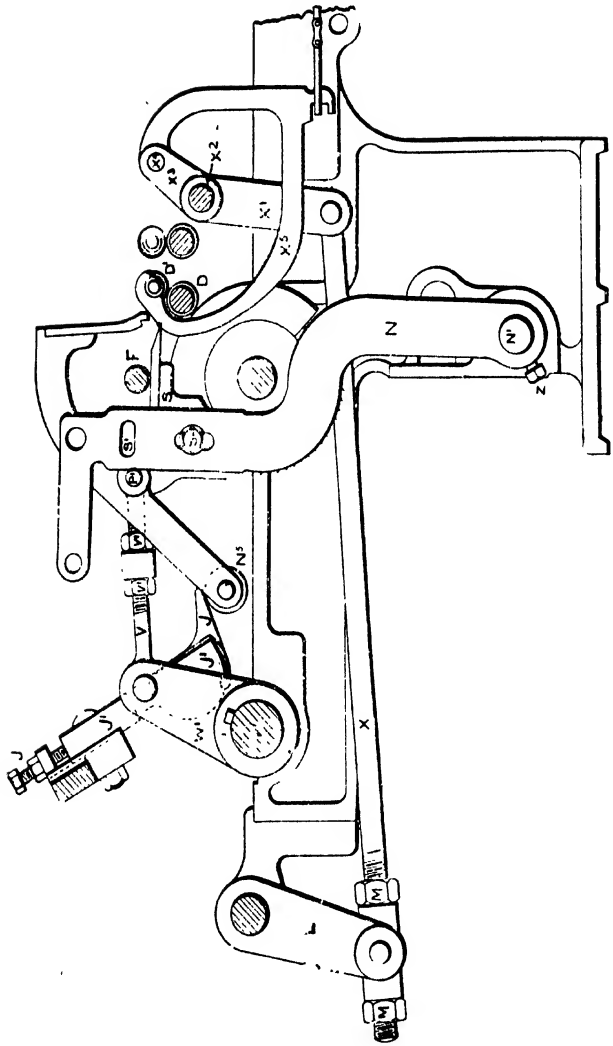


FIG. 14.

gradually raised to keep the comb clean. Thus the height at which the bar I is adjusted determines the moment when the top comb enters the fleece, and the set screws C^1 the depth of penetration. It will be noticed from the foregoing that the opening and closing of the nipper, the raising and lowering of the top comb, and the rotation of the feed roller all result from the re-

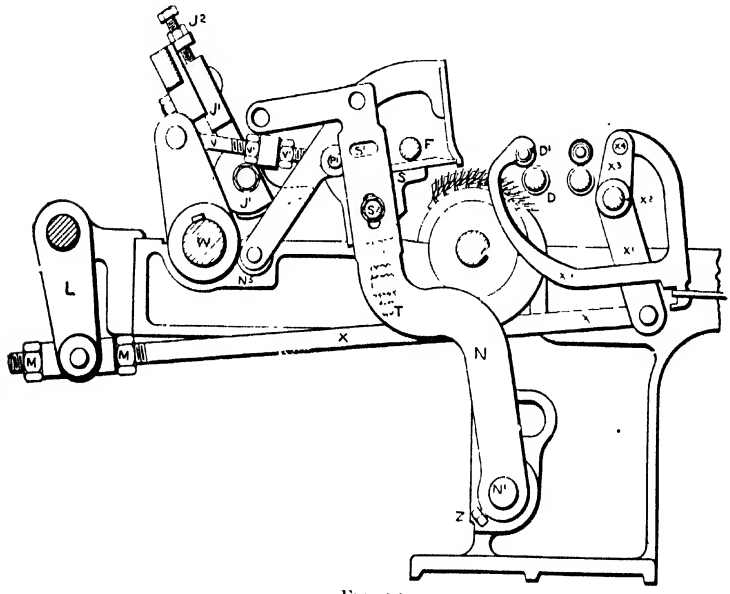


FIG. 15.

ciprocating motion of the nipper driven by a simple crank.

The position and action of the steel detaching roller D (figs. 14, 15, and 16) is identical with that of the Heilmann machine, except that the rotation of the roller continues a much greater time during each stroke in the Nasmith than in the Heilmann comb. The surface speed of the roller never exceeds that of the Heilmann

roller; it only takes a longer time to perform its greater arc of revolution. Again, the surface speed of the Heilmann roller must coincide exactly with that of the fluted cylinder, and after backing-off it must acquire this speed in the briefest possible fraction of a stroke. The leather roller of the Nasmith machine never coming into contact with the cylinder, no such embarrassing restriction exists, and the rollers stop and start gently, the cam being designed to start and stop the sector just as a crank would.

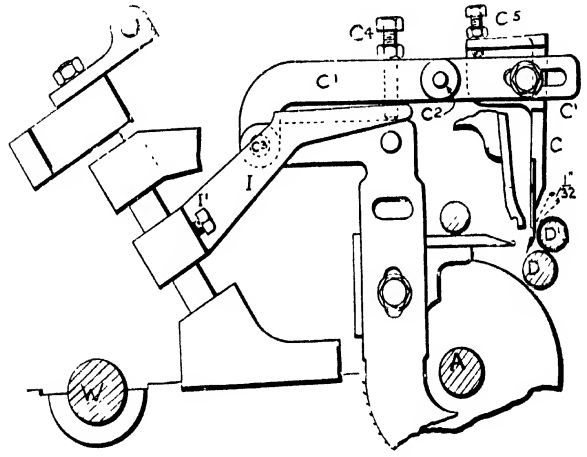


FIG. 16.

The leather-covered detaching roller D (figs. 14, 15, and 16) never comes in contact with the cylinder, but simply rests upon the bottom roller, from which it receives its rotary motion, and in addition to this it receives a bodily movement to and fro from the position of fig. 14 to that of fig. 15. This is obtained from the lever L keyed on its shaft and operated by a simple eccentric on the cylinder shaft. The connection is made through the rod X with adjusting screws MM to the lever X^1 and the weight hook X^5.

Five important advantages result from this disposition, viz.:—

(1) The time available for detaching and drawing through the top comb is greatly prolonged.

(2) The top roller is as easily set as a drawing head roller, doing away with any delicate adjustment.

(3) No definite and fixed surface speed of the roller is imposed, and a smooth cam takes the place of the abrupt notch wheel cam.

(4) The shock and deflection of the leather roller dropping on the cylinder under the influence of weights is done away with, and a 25 lb. weight easily works a 10½ in. lap of 600 or 700 grains per yard.

(5) A long overlap and perfect piecing are obtained even with ⅞ in. staple.

The cycle operations may be followed through by referring to views A, B, and C (fig. 171), which show the main organs of the Nasmith comber in three positions. The first (A) shows the needles passing through the end of the lap, held down by the closed nipper, which is in its rearward position (the dead point of the crank). Before the fine needles have passed, the nipper is already moving forward in the same direction as the cylinder, thus reducing the effective speed at which the needles are passing through the fibre and easing the strain on the latter. In view B the needles have passed, and the nipper is about the middle of its path towards the detaching rollers. As the last row of needles passes under the detaching rollers the latter turn backward, and owing to the top roller leaning towards the cylinder, the end of the combed fleece thus delivered backward is projected into the space between the last row of needles and the plain segment, the front edge of which strokes the fleece close against the under and bottom roller, so as to present a clean surface to the advancing nipper tuft for piecing. Meantime, the nipper having opened, the lap end rises automatically, and the points directly towards the nip of

the rollers. It would rise higher, but is met by the falling top comb and kept in proper position. The detaching rollers now begin to turn forward and seize the tips of the fibres presented by the advancing nipper, and pull the lap end into the top comb. The nipper continues to

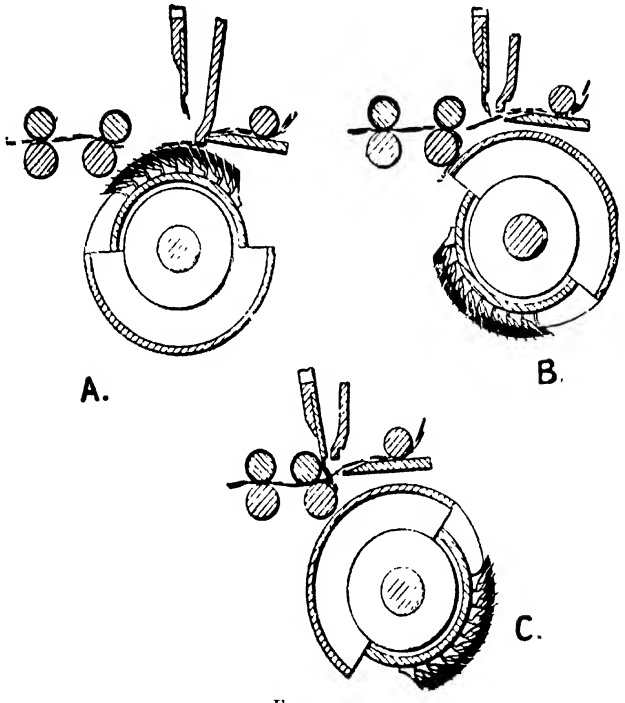


FIG. 17.

advance, but with diminished speed (approaching the dead point of the crank), thrusting the end of the lap gradually into the nip of the rollers, which successively seize fresh fibres and draw them off through the top comb. The top roller moves away before the advancing nipper and top comb, but is eventually overtaken by

them as both the nipper and roller arrive at the end of their respective paths; this is best seen in figs. 16 and 17. The rollers continue their rotary movement an instant longer to commence the separation, which is completed by the withdrawal of the nipper and top comb, leaving a short combed end projecting from the rollers, and the process recommences.

The overlap of the piecing thus obtained is about 2 in., as compared with about $\frac{5}{8}$ in. on a Heilmann for any staple. Further, the detachment is a comparatively slow and continuous operation compared with a practically instantaneous snatch in the Heilmann, as both leather roller and fluted segment are moving at full speed when they fall together, whereas the rollers in the Nasmith comb are only starting up slowly when they seize the nipper tuft. Again, the Heilmann roller drops on the nipper tuft about $\frac{3}{8}$ in. to $\frac{1}{2}$ in. from the tip, and, so to speak, in the thick of the lap, where it draws with difficulty, whereas the Nasmith rollers seize the lap by the extreme tip, where it draws easily and without undue strain. The Heilmann rollers have to complete the separation without assistance from the nipper, consequently much of their forward movement is unproductive; while the forward motion in the Nasmith rollers is almost entirely used for producing the separation, being completed by the retirement of the nipper.

The waste produced varies from 5 to 30 per cent., according to the material and the desired degree of combing. The quantity is under complete and easy control, and may be altered to any extent in a few minutes. The chief factor in determining the length, and consequently the amount of the waste, is the distance between the nipper and the steel detaching roller when the nipper is at the forward end of its path. This distance, on all the nippers of the machine, may be simultaneously altered by screws *a* and *b* (fig. 13).

The work of the Nasmith comber may be classed under three heads, viz.:—

(1) Fine combing proper, when it does the same work as the Heilmann. In this case not more than twice the production of the Heilmann for the same quality should be attempted, and for Sea Islands cotton not more than 75 per cent. more.

(2) Medium combing, where high productions and low waste may be obtained.

(3) Coarse combing, to take the place of fine carded yarns or ordinary carded yarns. In this case special cylinders and top combs are used, and a high production attained with waste from 5 to 8 per cent.

The yarn is not to be compared with real combed yarns, but is better than any carded yarn, even when, in preparation for this combing, the card production is pushed to its limit and the card waste reduced to 2½ per cent. For this class of work 1,000 lb. may be put through both card and comber weekly. This high production and low waste opens again for spinners the question of combing for ordinary and medium yarns.

Fig. 18 shows a six-headed Nasmith comber, which occupies the same space as a Heilmann machine of the same number of heads and width of lap. The headstock is cast in a solid piece. The bearings of the cylinder, nipper shafts, and detaching rollers are split bushes, easily renewable when necessary. The nipper pivots are plain studs in cast-iron bushes. The brush and doffer shafts can be lifted straight out behind without disturbing anything else. The front plate extends backwards to the detaching rollers, completely covering the calender shaft. A convenient weight relieving motion obviates the lifting of the detaching roller weights by hand. A selvage guide between the detaching rollers ensures perfect selvages. The drawing head is made with four rows of rollers.

Messrs. Hetherington's detailed instructions for setting Nasmith's patent comber are as follows:—

The index plate is divided into 40 parts, every fifth mark being numbered 5, 10, &c., up to 40.

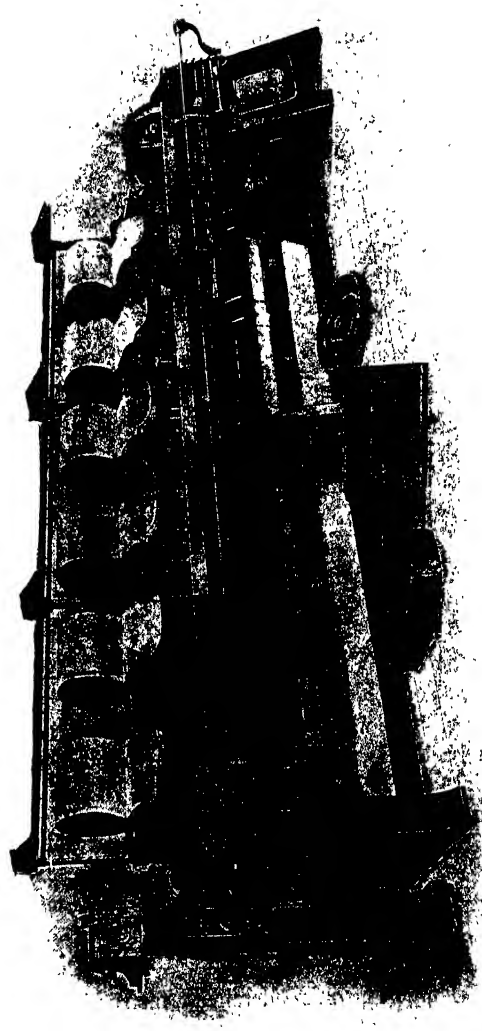


FIG. 18.

Setting No. 1.

At index $2\frac{1}{2}$, set the cylinders in the middle of each head and screw them tightly on the shaft so that the front edge of the plain segment is gauge 1 ($2\frac{1}{2}$ in.) from the back of the steel detaching roller (fig. 18A, p. 35).

Note 1.—The bearing of the roller D, if disturbed, should be set to the mark on the stands; it will then be at the proper distance from the plain segment. The set screws for fastening the cylinder are discovered by removing the tin strip behind the last row of needles.

Note 2.—After setting the cylinders, put on the front calender and the table and set the brush tins to clear the

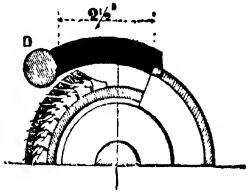


FIG. 18A.

cylinders equally at the back and front and at the ends, so that the top edge of the tin is $\frac{1}{16}$ in. from the underside of the inner edge of the steel detaching roller.

THE NIPPER CRANK STUD.

Setting No. 2.

Screw up the stud M in the slot in the index plate so that its centre is radially opposite mark 37 (fig. 13, p. 25). Put in the slide bar R and bolt it up with the set screws *a* and *b* bearing on it and each projecting equally.

Note 3.—The stud M should always be in this position when setting, but may be moved a little either way to

make a good piecing, according to the cotton worked, without affecting any other setting.

Note 4.—The position of this stud determines the *time* when the nipper reaches the detaching roller, on which a good piecing mainly depends. Generally speaking, it should be as early as possible, but if too early, the tips of the fibres composing the nipper tuft are curled slightly by touching the roller before its forward motion has commenced. Also the roller continues to turn too long after the nipper has withdrawn, and the end is carried too far into the rollers, which is especially undesirable with short cotton. On the other hand, if it is too late, a straggling separation and useless waste is made.

The Nipper.

Setting No. 3.

At index 19, the nipper being at the forward end of its stroke, set the bottom jaw (cushion plate) parallel to the steel detaching roller by means of the nuts V V (figs. 14 and 15, pp. 27 and 28) and at the required distance from it (see Notes 5 and 7). The pivot set screws Z must be loose when this is done.

Setting No. 4.

At index 33, loosen the Screw S^2 (fig. 15, p. 28) and with the raising screw T, set the nipper (with springs on and without cotton in) $\frac{25}{1000}$ of an inch from the needles. The screws Z must be fast when this is done and the bowl N^5 clear of the incline J.

Note 5.—Gauge No. 2 is $\frac{1}{2}$ in. thick, and the numbers on the stepped flats, from 8 to 15, represent thirty-seconds of an inch.

Note 6.—In setting for the first time, proceed as follows: After setting No. 2, turn till the plain segment on the cylinder is uppermost. Put the nipper in and, the springs being off, turn backwards to No. 33. Then press

the top knife gently on the bottom one, and see that it clears the needles. Loosen the forked levers on the shaft W by driving out the keys (fig. 15, p. 28). Couple the connecting rod by the screws V^1 V^1 to the nipper swivel and key the levers up again on the shaft W, so that the nipper is exactly in the middle of the cylinder, the screws Z being loose. Turn to index 19, and by means of the nuts V^1 V^1 set the nippers temporarily, say to flat 12, gauge 2, from the steel detaching roller. Then turn to index 27, put the nipper springs on and adjust the nuts, so that there is no tension on the springs beyond what is necessary to keep the nuts in the grooves. Then turn backwards to index 33 and perform Setting No. 4, always tightening afterwards the screws S^2 before proceeding. Turn again to index 19 and perform Setting No. 3 exactly, securing the nuts V^1 V^1. Tighten afterwards the set screws Z. Finally turn again to index 33, and, if necessary, re-perform Setting No. 4. The nippers are then all in line with the cylinder and with the steel detaching roller. Their distance from the latter may be varied simultaneously as required (Note 7) by the set screws *a* and *b* (fig. 13, p. 25), without disturbing any other setting except that of the top comb, unless a large change is made. (See Notes 8 and 10.)

Note 7.—The distance of the bottom nipper plate from the steel detaching roller D (fig. 16, p. 29) at index 19, is the main factor in determining the length and consequently the amount of waste. Theoretically it is the only way, and should always be used if any considerable alteration in the amount of waste is to be made. The nearer the nipper comes to the roller, the shorter and the less will be the waste, and *vice versa*. For short cottons and low waste, it may be as near as flat 8, gauge 2; and for long Sea Islands and Florida cottons, flat 15, and for high percentages of waste, even $\frac{1}{2}$ in. may be used. For good Egyptian, use flat 11 or 12, which will give 14 to 16 per cent. of waste, unless there is an unusual amount

in the cotton. Further information on waste is given in Notes 9, 10, 11, and Setting No. 11.

Opening the Nipper.

Time.—Setting No. 5.

At index 27 set the leg J down till the incline J (fig. 14, p. 27) just touches the bowl N^5.

Note.—The nipper should, in general, open as late as possible, but if too late, it will, in closing, strike the lap out of the top comb before the separation is completed, which must always be avoided.

Amount of Opening

Setting No. 6.

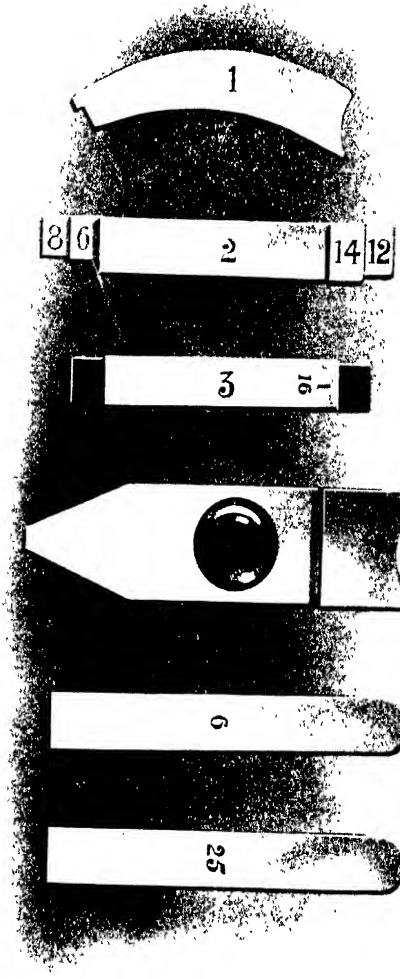
At index 19, place gauge 2 on the steel detaching roller and with flat 12 ($\frac{3}{8}$ in.) between the nipper jaws, loosen the bolt that secures the incline J to the leg J^1 and dip the point of the incline till it touches the bowl N^5 (fig. 14, p. 27).

Note 8A.—If the nipper does not open wide enough, a poor piecing may result. For very short cotton flat 14 may be used. A slight alteration in the distance of the nipper from the detaching roller at index 19 will not greatly affect Settings Nos. 5 and 6, but if a large change is made, it is advisable to reset them.

The Top Comb.

Setting No. 7.

At index 19 the points of the top comb needles must always be $\frac{1}{16}$ in. (gauge 3, fig. 19, p. 39) from the inner steel detaching roller. The slots in the comb arm C^1, in conjunction with the angle screw C^5 permit this adjustment (fig. 16, p. 29). A medium angle is to let the arm



Face p. 30

C^1 project $\frac{5}{8}$ in. beyond the comb bridge C. Use only one angle screw when setting and run the other back till all is fixed.

Depth of the Comb.

Insert the end of a $\frac{6}{1000}$ in. doctor gauge below the needle points, letting it rest on the steel roller. Then by means of the screws C^4, lower the comb till the doctor rises from the front steel roller $\frac{1}{14}$ in. (see Note 9 and fig. 19, p. 39).

Note 9.—It is not advisable to lower the comb more than indicated above, and it may more frequently allow the doctor or even a $\frac{25}{1000}$ in. gauge to rest on the front roller. If, when the doctor is $\frac{1}{16}$ in. above the front roller, the waste is insufficient, move the nipper back

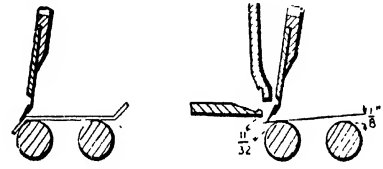


Fig. 19.

(Setting No. 3 and Note 7), moving the comb to the same position as before (fig. 19). This puts the comb into the lap further forward, increases the length and amount of waste and improves the cleanliness. Dropping the comb or increasing the angle to make more waste is a drastic method, pulling the waste out by main force without improving the cleanliness, and can only be employed with long cotton, light laps, and when the nipper is set well back.

Note 10.—If less waste is required and the nipper is to be brought nearer the detaching roller, the top comb must be first set back lest it touch the roller, and when the nipper is adjusted the comb must be reset as indicated in Setting No. 7.

The Top Comb Lifters.

Setting No. 8.

At Index 11, set up the lifters I (fig. 16, p. 29) to touch the bowls C^2.

Note 11.—In working short cottons with low waste, Setting No. 8 may be done as late as index 13. It must not be too late, otherwise the comb fails to do its work and is lifted out before the separation has been completed, which is undesirable. This is specially to be guarded against in long cottons.

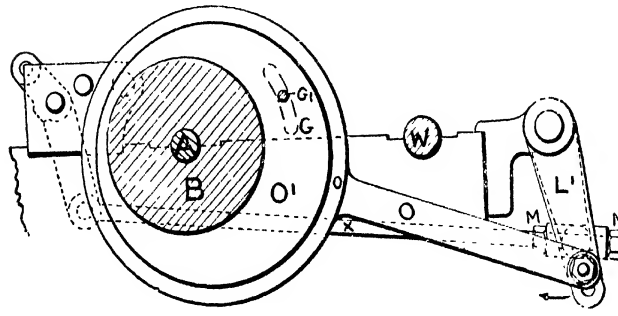


Fig. 20.

The Feed Roller.

Setting No. 9.

For Egyptian and Sea Islands cottons set the roller back as far as the slots S^1 (figs. 14 and 15, pp. 27 and 28) will allow. For short cottons and less waste, the roller may be brought $\frac{1}{4}$ in. further forward. Set the feed roller springs to put as little tension as possible on the roller. The amount of feed is regulated by the position of the pin in the feed roller ratchet lever, 5 teeth (equivalent to $\frac{1}{4}$ in. of lap per stroke) is usual, 4 and 6 being also provided for. The lap roller ratchet must take as many

teeth each stroke as the feed roller ratchet and should be set to take half a tooth more than the required number.

Note 12.—Too much weight on the feed roller puckers the lap and gives a cloudy fleece. A 42 change pinion is sent on the lap roller ratchet, and a 41 is sent for use with short soft cottons, to keep the lap tight between the lap and feed rollers.

To Time the Detaching Rollers.

Setting No. 10.

Loosen the cam and turn it back as far as it will go. Then turn to index 1 and move the cam forwards till the roller begins to turn backwards. Test this setting by turning the machine by hand, as it is important that the roller begin to move precisely at index 1.

The Top Leather-covered Detaching Roller.

Setting No. 11.

Time. At index 20, set the eccentric O^1 (fig. 20, p. 40), by means of the Screw G^1 and the slot G, so that the level L^1 just begins to move inwards in the direction of the arrow.

Position. At index 19, the leather roller should be as near the top comb blade as it will work without rubbing. (Say $\frac{1}{32}$ in., fig. 16, p. 29.) If further away useless waste is made.

Note 13.—In early machines the lever L (fig. 14, p. 27) was fastened on the shaft W and the roller rocked exactly in time with the nipper. In such machines set the lever L vertically below the shaft W at index 34.

Note 14.—In machines of four heads there is one, and in machines of 5 and 6 heads two levers X^1 (fig. 14, p. 27) cast together with the forked levers X^3, and keyed on the shaft X^2, the remaining forked levers X^3

carrying the weight hooks X^5, can be clipped on the shaft in any position. The leather rollers are to be first set all parallel with the bottom roller, and each equidistant from the top comb blade at index 19. Commence with the compound levers X^1, X^2, and adjust by means of the nuts MM, and then clip the short forked levers X^3 on to the shaft in proper position. When this is done the rollers operated by each compound lever X^1 may all be set simultaneously to the proper distance from the top comb blades by means of the nuts MM (figs. 14 and 15, pp. 27 and 28).

Note 15.—In almost every case the 25 lb. weights are sufficient to put the necessary pressure on the leather roller. Two separate 5 lb. weights are sent with each 25 lb. weight in case they are required for very heavy work. The leather rollers of the front and back lines are interchangeable. They should be carefully covered, ground and varnished with suitable varnish and kept in good order. Keep the pivots lubricated by oiling frequently, and very little at a time.

The Detaching Roller Clutch.

Setting No. 12.

Set the ring on the coupling so that the clutch begins to move at index 38. Then loosen the shed on which the clutch fork pivots and turn to Index 10. Move the stud along its slot, away from the pulleys (towards the pulleys in 1903 pattern with horizontal clutch lever), as far as it will go without forcing, and fix it there, thus ensuring that the clutch will be held properly home. Turn them till the clutch is fully out (index 28), and set up the holding peg against the clutch and in the centre of a tooth, to prevent the accidental displacement of the clutch whilst out and to hold it in the proper position to go right in.

Note 16.—The carrier wheel connecting the two steel rollers must be as deeply geared with both wheels as possible without binding. Backlash is undesirable between the rollers and the cam.

General Observations.

Preparation of laps. Heavy laps are more liable to be irregular than light ones, unless care is exercised in drafting and roller setting in the lap machines.

Testing a yard at a time gives no reliable indication of regularity. Laps should be rolled out on a board having transversal grooves every 6 in., and should be cut into exact 6 in. lengths with scissors

Weight of the Laps.- The 10½ in. laps may weigh:—

For superfine work from Island cotton, 13 to 18 dwts. per yd.; for medium work from Florida cotton, 18 to 22 dwts. per yd.; Egyptian and American cottons, 22 to 32 dwts. per yd. For Sea Islands and light laps a fine cylinder is recommended, with 33 top combs, 81 needles to the inch. For Egyptian and Long American, the standard cylinder, with 28 top combs, 66 needles to the inch, is used. In all cases the top comb needles should project $\frac{3}{16}$ in. from the comb stock.

Amount of Feed.--Four or 5 teeth of feed may be taken, the former for the finer work, but 6 teeth are rarely practicable. It is better to work with a heavy lap and light feed, than a light lap and heavy feed.

To pass the laps through, bring the nipper to its forward position, lift the end of the feed roller by the knob on the left and point the end of the lap below it. It may then be turned by the knob until the end of the lap is in the nipper. Owing to the weight of lap worked, care should be taken in putting a new lap on that the two ends do not overlap more than is necessary, so as not to damage the needles by a long length of double lap. The feed roller may be taken out by lifting the top comb and

top nipper after unhooking the springs. Keep the nipper plate below the roller bright by cleaning it occasionally. The hard waste that may collect at the nipper ends should be removed weekly.

To brush out the cylinders lift the feed roller and lap roller ratchet catches. Then run the machine, when no cotton will go forward. It is unnecessary to break out the laps.

Production formulæ.—Good work with fairly carded Egyptian cotton can be obtained on the Nasmith comber by using a 25 dwt. lap and 5 teeth of feed. At 100 strokes per minute, with 15 per cent. of waste, rather over 800 lb. can be got from a 6 headed machine in fifty hours. The general production formulæ are as follows:—

P=The pounds produced per head per hour continuous working.

R=The number of teeth of the lap ratchet taken each stroke.

W=The weight in grains of a yard of lap after deducting the waste.

X=The teeth in the change wheel on the lap ratchet (usually 42).

$$P = \frac{100 \times R \times X \times 35 \times 2{\cdot}75 \times 3{\cdot}1416 \times 60 \times W}{75 \times 80 \times 47 \times 36 \times 7{,}000} = \frac{R \times X \times W}{3918{\cdot}9}$$

or if X is the usual 42, $\frac{R \times W}{93{\cdot}307} = P$. Then if R is 4 teeth, $\frac{W}{23{\cdot}3} = P$, and if R is 5, $\frac{W}{18{\cdot}66} = P$.

The gearing of the drawing head (fig. 21, p. 45).—To determine the total draft between the lap and the sliver:—

If W = the weight of a yard of lap in grains, after deducting the loss in waste.

N = the number of laps up or number of heads.

S = the grains in a yard of sliver.

Then the total draft, $T = \frac{W \times N}{S}$

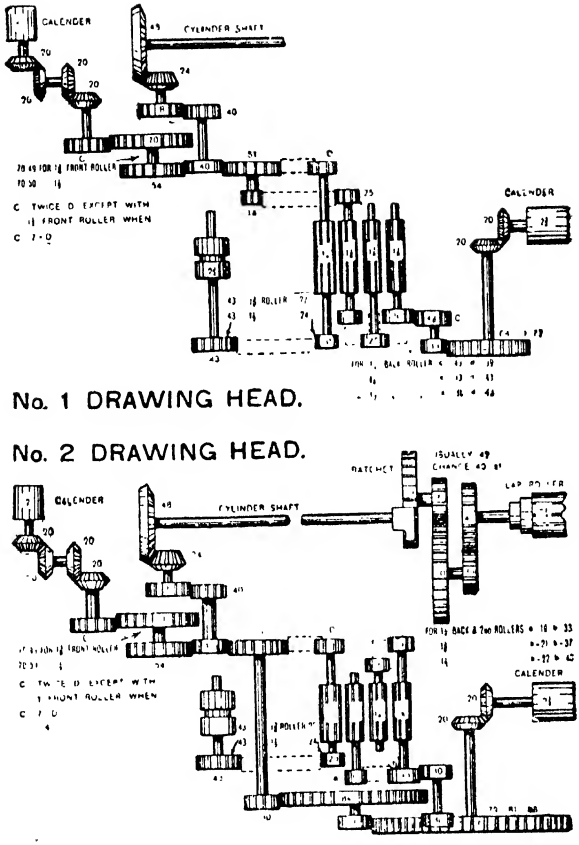


FIG. 21.

To determine the draft wheel to give any required total draft:—

Let R = the number of teeth of the lap ratchet taken every nip (4 or 5).

C = the number of teeth in the cross shaft wheel (60, 66, or 77).

And D = the number of teeth required in the draft wheel.

In calculating the total draft, consider the lap roller as driving through to the coiler top, then for No. 4 drawing heads we have—

$$\frac{47 \times 80 \times 75 \times C \times 88 \times 2\frac{1}{16}\text{ in.}}{35 \times 42 \times R \times D \times 63 \times 2\frac{1}{4}\text{ in.}} = T, \text{ the total draft.}$$

whence $\frac{201 \times C}{RT} = D.$ (The draft wheel).

From this a constant is determined for all values of C and R. The former is 60, 66 or 77, and the latter 4 or 5.

Teeth of feed	Cross shaft wheels		
	60	66	77
4	3,015	3,318	3,870
5	2,412	2,652	3,095

These numbers divided by the total draft give the draft wheel.

Example: With six laps up weighing 25 dwts. per yard and deducting 15 per cent. for waste with 50 grains per yard in the sliver, the total draft would be

$$T = \frac{510 \times 6}{50} = 61{\cdot}2.$$

Then, if 66 be on the cross shaft and 5 teeth of feed are taken each stroke on the feed ratchet, the constant from the table is 2652, and the draft wheel is

$$\frac{2652}{61{\cdot}2} = 43 \text{ nearly.}$$

In starting a machine put the proper draft wheel on, calculated as above, then get the draft on the table as low as possible by the wheel A. The calender, being

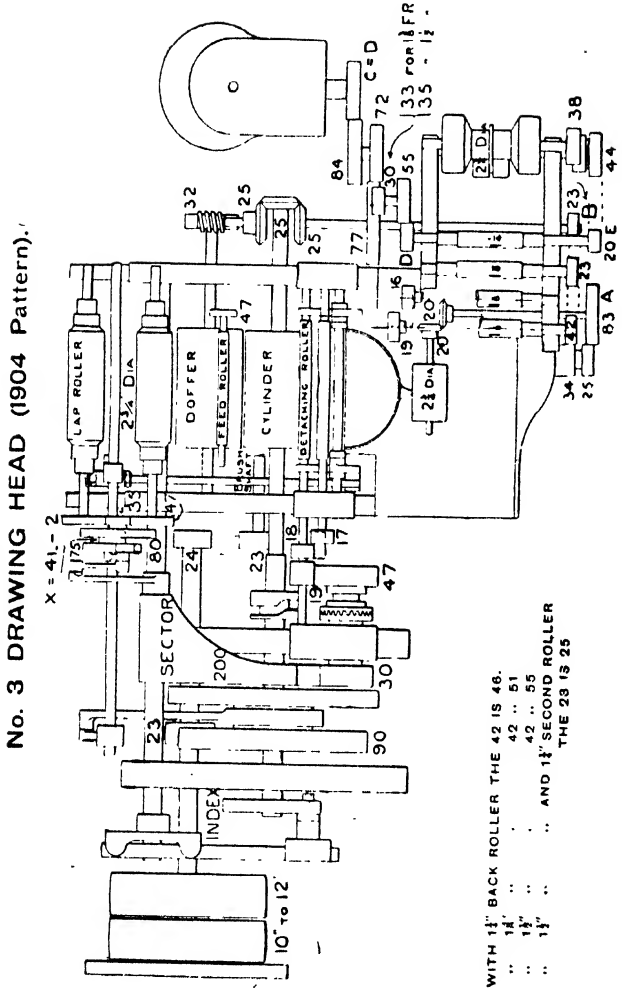

No. 3 DRAWING HEAD (1904 Pattern).
X = 41 - 2
LAP ROLLER
2¼ DIA
DOFFER
FEED ROLLER
CYLINDER
DETAINING ROLLER
SECTOR
INDEX
10" TO 12"
C=D
33 FOR 1¼ FR
35 - 1¼ -
21 DIA
WITH 1¼" BACK ROLLER THE 42 IS 46.
" 1¼" " " " 42 " 51
" 1½" " " " 42 " 55
" 1¾" " " AND 1¾" SECOND ROLLER
THE 23 IS 25

FIG. 22.

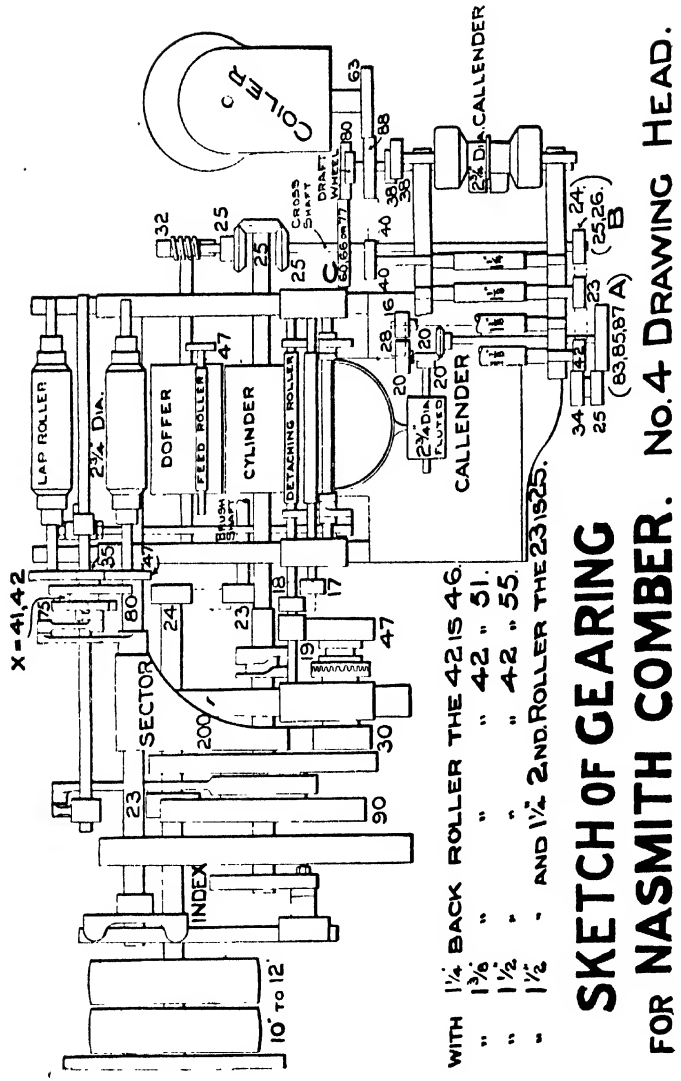

SKETCH OF GEARING
FOR NASMITH COMBER. No. 4 DRAWING HEAD.
WITH 1¼ BACK ROLLER THE 42 IS 46.
" 1⅜ " " " 42 " 51.
" 1½ " " " 42 " 55.
" 1½ " AND 1¼ 2ND. ROLLER THE 23 IS 25.
X = 41, 42
LAP ROLLER
2¾ DIA.
DOFFER
FEED ROLLER
CYLINDER
DETACHING ROLLER
BRUSH SHAFT
CALLENDER
2¾ DIA. FLUTED
2¾ DIA. CALLENDER
COILER
CROSS SHAFT
DRAFT WHEEL
SECTOR
INDEX
10' TO 12'
(83,85,87 A) B
(25,26.)

FIG. 23.

fluted, causes this wheel to vary according to the weight of sliver, a lighter sliver requiring a larger wheel. Then adjust the tension in the tin between the detaching roller and the calender by changing the speed wheel B if necessary. At index 8, the fleece should be just tight without stretching. There should be as little draft as possible between the detaching roller and the draw box.

In No. 3 Drawing Head the cross shaft wheel is always 77, and in altering the draft both the coiler wheel C and the draft wheel D must be changed. Both must have the same number of teeth. The constants are:—

With 4 teeth of feed, 3234.
" 5 " " 2585.

Full plans of Nos. 3 and 4 drawing heads and plans of Nos. 1 and 2 drawing heads are given, but the constants for the two latter are not so simple as above, owing to the variable wheel B entering as a factor.

CHAPTER IV.

THE DELETTE COMB.

Among other short-fibre combs on the Heilmann principle perhaps the best known is the Delette machine, which is considerably used on the Continent, although practically unknown in England, partly for the reason that the English patent rights have been bought up by the proprietor of the Nasmith comb.

The Delette comb for cotton differs from the Heilmann machine proper in that the circular comb is of small diameter, and has no drawing-off segment. The nippers, besides opening and shutting, have a backward and forward motion, which draws the slivers down and produces a feed. The comb circle or cylinder has a reciprocating rotary motion, and a fluted presser-in rides over the comb circle as the combs pass through the fibre, the deep flutes passing between the rows of needles and keeping the fibre well down, so that it is thoroughly combed. Drawing-off is effected by four oscillating rollers, two of which detach while the others draw off. A holding-up blade or tongue shoots out between the jaws of the nipper as they open, and, being below the fibre, hold the latter up into the pins of the fixed comb while drawing-off takes place, thus insuring that all the tail-end fibres are thoroughly combed out. The machine has usually four heads, and can comb cotton from 1⅛ in. to 2⅛ in. in length, with an average production of 120 lb. to 130 lb. per ten hours.

The Delette comb is better known in this country when used for combing fibres longer than cotton, flax tow,

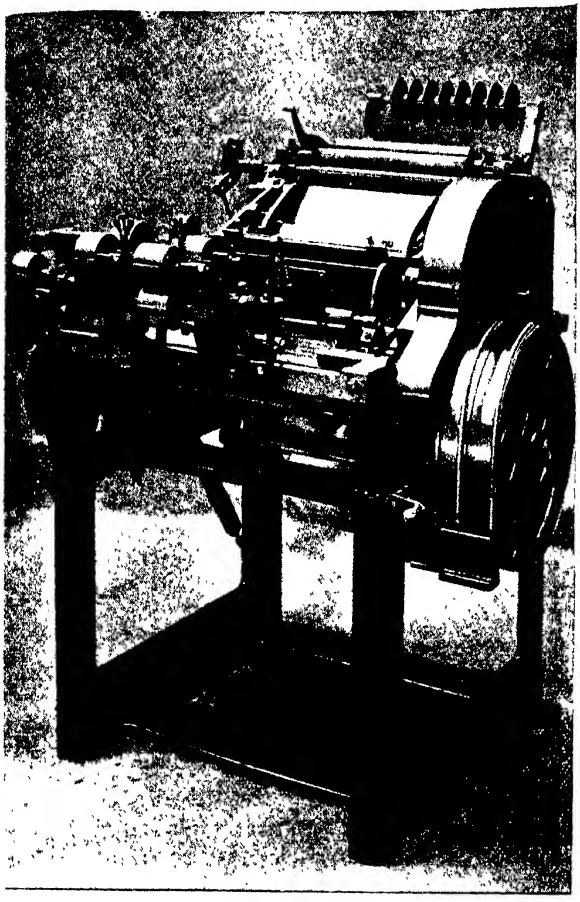


FIG. 24.

and ramie, for instance. For this purpose it is probably unequalled by any other comb. Fig. 24 shows the

machine as very considerably used in the flax-spinning trade at home and on the Continent, while figs. 25, 26, 27, 28, 29, and 30 show the most important organs more in detail. As it will be noticed from fig. 24, the long-fibre comb is invariably a single-headed machine. It is fed by slivers from the first drawing frame to the number of either fifteen or eight, some spinners preferring to feed with eight heavy slivers instead of fifteen lighter ones. The object is to get a level feed across the whole width of the machine. Without this the best results will not be attained, for the nipper may not hold the material properly during the passage of the circular comb, and the drawing-off rollers, being unequally loaded, may not draw off properly.

The slivers pass from the cans over an ordinary back and sliver guides and back sliver plate to a pair of fluted feed rollers, which have an intermittent motion given to them by means of a cam, lever connecting rod, ratchet wheel, and pawl. They feed forward either $\frac{1}{3}$ in. or $\frac{1}{2}$ in. for every stroke of the comb, according to the cam which is used and the number of teeth taken each time on the ratchet wheel, either four or five teeth, which is easily regulated by shifting the point of connection of the cam lever and connecting rod in a slot in the former. Leaving the feed rollers, the slivers pass through a brass grid and intersecting gill arrangement, which, while opening to allow them to be drawn forward by the nipper, in a manner presently to be described, closes again to prevent uncombed fibre being drawn forward through the open nipper by the tail ends of those which are caught in the drawing-off rollers. The actual feed forward of the slivers is, as we have said, produced by the nipper jaws, which, besides opening and closing, have a backward and forward motion, moving backward when open, then closing upon the slivers and drawing them forward the distance specified, either $\frac{1}{3}$ in. or $\frac{1}{2}$ in. When the nipper is in its forward position, and firmly closed upon the

protruding fringe of fibres, the comb segment comes round and combs out all short fibre and naps. When the comb segment has passed the fixed comb comes down and penetrates the protruding fringe of fibres, the jaws of the nipper open, and the drawing-off rollers come up, seize the protruding ends of combed fibre, and draw them forward through the pins of the fixed comb, which they cannot override, since a tongue shoots out between the nipper jaws as they open, and, being below the fibre and above the points of the pins in the fixed comb, makes it impossible for the fibres to escape being combed. The drawing-off rollers, besides making several revolutions every stroke to draw through the tail ends of the fibres, move backward and forward to and from the fixed comb with the table or carriage, leaving plenty of room for the descent of the sword or scythe which, with a descending stroke, passes between them and completes the drawing through of the tail ends of the fibres, and thus leaves a sufficient length to be spliced up automatically with those caught by the drawing-off rollers next time they rise up close to the fixed comb. The holding-up blade or counter-scythe *a*, fig. 28, comes up between the fixed comb and scythe, and holds the fibres up into the comb while the scythe makes its downward stroke, the fibres being drawn over its edge. The fibres are thus combed in their entire length, the front part by the circular comb and the tail ends by a passage through the fixed comb. They are spliced together again as described before leaving the drawing-off rollers, from which they emerge in a light fleece, which is carried forward upon an endless leather apron, which passes round the lower of the two fluted drawing-off rollers. This fleece is condensed into a sliver in its passage through a trumpet mouth and two pairs of spring-pressed calender rollers, which deliver it into a can.

The comb circle, with its thirteen rows of comb bars or slips screwed to a brass segment attached by grub

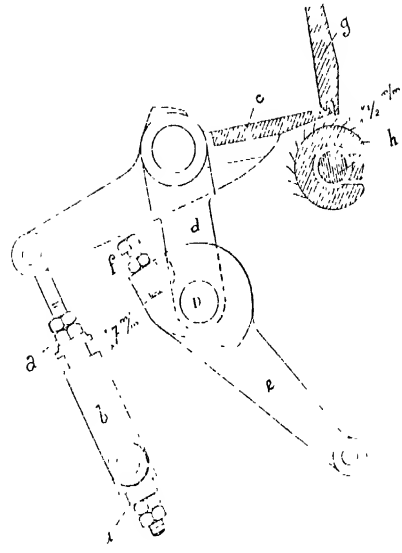


FIG. 25

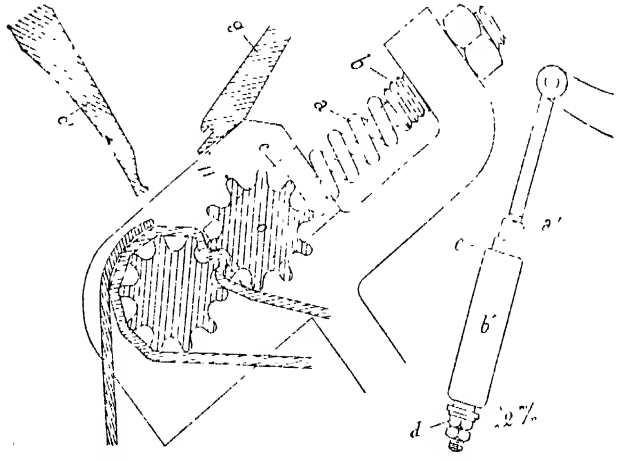


FIG. 27. FIG. 26.

screws to the reciprocating shaft *h*, is clearly to be seen in fig. 25, as is also the lower nipper jaw *c* and the upper jaw *g*. In fig. 27 the nipper jaws are open, and the fluted drawing-off rollers, with the endless leather apron between them, in their highest position. This figure also shows how pressure is applied to the upper drawing-off roller *o* by the adjustable screw *b* and compressed spring *a* bearing upon the roller brass at each end. Fig. 28 shows the drawing-off rollers in their top position, the upper roller as near as possible to the fixed comb D without touching it. Figs. 29 and 30 show a most important organ of this improved comb, viz., the fluted presser-in A, which rides over the top of the comb circle, the flutes meshing between the rows of pins and rendering it impossible for any fibre to ride over the pin points and escape being combed.

Like other combs, the setting of the various organs and the correct timing of their movements is of the greatest importance if the machine is to work efficiently. Unlike other combs, however, there is but one setting, which is easily made. The first thing to do when a new machine arrives is to have it put in place and thoroughly cleaned, all grease being more especially carefully removed from the pins of the combs and from the sword, the latter especially being carefully dried and polished with whiting. The machine being levelled up to a suitable height for the delivery can, and made perfectly steady by suitable pitchpine packings under the four corners of the frame, it next remains to verify the setting of the various organs. Among the gearing on the driving side of the machine there will be found two spur wheels of 55 teeth each, communicating motion from the driving shaft to the organs at the front and rear respectively. It will be found that a space between two adjoining teeth in each is marked with an O, and that pins have been inserted in the framework front and rear of the gable, which pins should both be opposite the O's

on the wheels at the same moment. If it is found that this is not the case, one of them must be set right, an intermediate wheel being removed and the other turned into position, when the intermediate wheel must be put

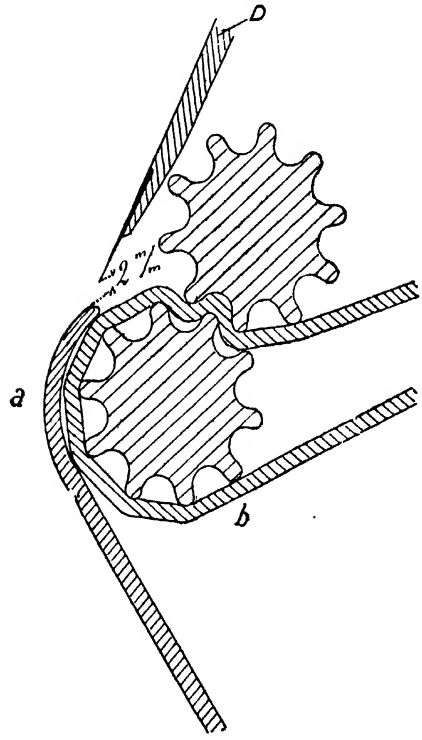


FIG. 28.

into gear again. The machine is conveniently turned round by hand by means of a hand wheel on the left side of the machine. There is also a marked tooth in a pinion of 20 teeth upon the circular comb shaft, which tooth must gear into a marked space between two teeth in the

internal-toothed segment which gives the comb circle its reciprocating rotary motion. This marked space, above referred to, is the thirteenth counted from above. Another

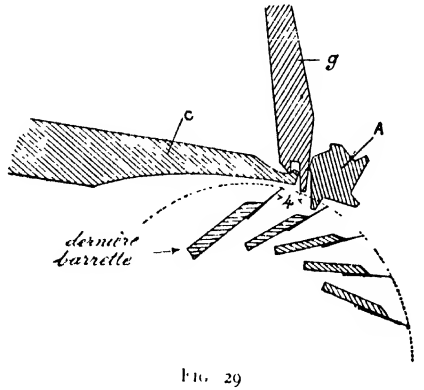


FIG. 29

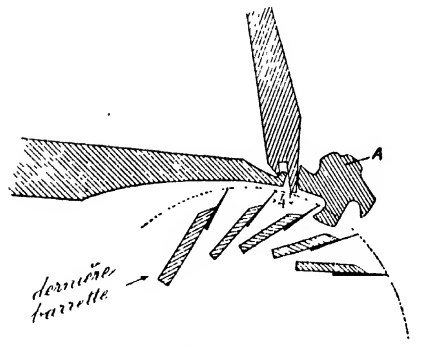


FIG. 30.

position which is fixed is that of the lower jaw of the nipper when the latter is open. This is set in the shop and a line drawn across the junction of the arms *e* and *d*, fig. 25, the relative position of which arms must never be changed.

When the nipper is fully closed and under pressure, the lip of the upper jaw should be quite close, say $^1/_{32}$ in. from the points of the pins of the circular comb as they pass under it. This distance may be adjusted either by shortening or lengthening the connecting rods through the lock nuts *a*, fig. 25, or else by shifting the lock nuts below the buffer stops *i*, which, by coming in contact with their spring boxes, determine the distance to which the lower jaw may be pressed down by the pressure of the upper one. In getting the correct pressure on the nipper it is necessary to understand that the lower jaw is pressed upwards by the springs in the boxes *b* at either side, and that it is not until the lower jaw has been pressed down to rock bottom, or until the buffers *i* come in contact with their boxes, that any effective pressure goes on. The upper jaw of the nipper is pressed downwards by the spiral spring enclosed in the box *b* (fig. 26). To get the correct pressure upon the nipper it is best to slacken off all pressure by turning back the lock nuts *a* (fig. 26), allowing the lower jaw to rise as far as it wishes to. The nuts may then be tightened up again until the lower jaw has been forced down to rock bottom, or until the buffers *i* (fig. 25) come in contact with the boxes. Firm pressure is then applied by giving the nuts *a* (fig. 26) four complete turns, or turning 24 sides one at a time, the nut being hexagonal. This having been done, set the buffer *d* (fig. 26) about $^1/_{32}$ in. from the box, as shown. Of course, it is understood that this setting is done at the time when the nipper is in its forward position, the circular comb moving forward underneath it. It must be borne in mind that the nipper must be under full pressure before the first row of pins comes beneath it, so that no combing takes place before the material is firmly held. Were this not the case, the tow would be pulled through the nipper jaws, and would choke the circular comb. Should the comb circle be too much in advance or behind, its position may be adjusted by

shortening or lengthening the link connected with the segment which drives it.

Next follows a series of settings, which should be made when the drawing-off rollers are in their highest position and the nipper open. As these settings are very close, great care must be taken that the drawing-off rollers *are* quite in their highest position, or that the friction roller is upon the highest point of the cam which brings them up. In this position there should be $\frac{1}{2}$ in. or slightly less between the upper drawing-off roller *o* and the face of the upper jaw of the nipper, as shown in fig. 27.

This distance may be adjusted by shifting the friction roller lever in slackening the two bolts which connect this lever to the carriage, and by turning the regulating screw in one direction or the other. By screwing in this screw the carriage is brought nearer to the nipper.

In this same position the fixed comb D (fig. 28) should be as near as possible to the upper drawing-off roller without touching it, as shown in the figure, and from $^{3}/_{10}$ in. to $^{4}/_{10}$ in. from the face of the upper jaw of the nipper. It should be parallel to the edge of the plate or tongue which comes out between the open jaws of the nipper, and about $^{1}/_{48}$ in. from it. This blade may be brought backwards or forwards by means of an adjustable friction roller arm. The height of the fixed comb should be such that the points of the pins are level with or slightly below the lower side of this plate or tongue. It should have reached its lowest position when the drawing-off rollers have turned $1\frac{1}{2}$ flutes forward. As seen in fig. 28, there is a holder-up *a* under the fixed comb, which holder-up should be set against the leather apron *b*, so that it encircles it closely. It should be about $^{1}/_{12}$ in. below the points of the pins of the fixed comb, so as to avoid all danger of catching upon them. This blade is adjustable as regards height by shifting the friction roller of the carriage by means of an adjustable

screw, and as regards distance backwards or forwards by shortening or lengthening a connecting rod. This setting having been made, the friction roller must be in contact with its cam.

There is a spring which unites the carriage to the friction roller arm. This spring must be kept in good order, so that this blade may work properly and clear the other organs.

The drawing-off rollers being still in their highest position, the lower edge of the sword or scythe must be at least $\frac{1}{8}$ in. clear of the top of the rubber upon the drawing-off roller, so as to avoid all risk of striking. The feed gill should be, say, $\frac{1}{64}$ in. clear of the upper jaw of the nipper when the latter is at its furthest back position.

Fig. 29 shows the method of setting the fluted presser-in A, which rides over the top of the combs in the comb segment. This fluted presser-in should be set so that the pins pass right into the middle of the flute, as shown, there being about $\frac{1}{24}$ in. between the flute and the pins behind it. This is easily arranged by slackening the grub screws which tighten the driving wheel of 44 teeth upon the shaft of the circular comb, and turning the circular presser-in right before tightening up again.

The first big flute of the fluted presser-in must come over the top of the last but one row of pins of the comb segment, as shown in fig. 30. This it will always do if the segment driving the comb circle be not removed. If, however, the latter is removed, and the comb circle given one or more turns in the same direction, it will be found that the first big flute no longer comes in right, and the circle will have to be turned round several times before it again falls into its place. The driving segment should then be immediately replaced in its correct position as regards the marked teeth, as before mentioned.

Pressure is applied to the drawing-off rollers by means of the screws *b* (fig. 27), which screws compress the

springs *a*. The pressure applied should be sufficient to give the rollers sufficient power to draw off clearly, but should not be unnecessarily heavy so as to unduly wear the leather and make the machine heavy to drive. The spring cleaning blades applied to the fixed comb are adjustable, and should be set so that their edges are about $^1/_{21}$ in. above the roots of the pins. The brush should be set so that the bristles touch the first comb bars. Since the bristles are apt to be bent backwards in use, the brush should be taken out and turned once a fortnight. As the bristles wear, the brush is easily raised by means of an adjusting screw. The doffer is set close to the brush in a similar manner.

To clean the comb circle, an operation which should be performed at least once a day, the machine should be turned round by hand until the nipper is fully open. The fixed comb is then thrown back as well as the feed gill and grid, which carries the slivers with it. The springs of the lever of the nipper shaft and of the feed gill lever are then unhooked, and the pin taken out of the link which connects the upper jaw of the nipper with its spring box. The friction roller lever arm, through which motion is given to the tongue plate, is then grasped with the right hand and raised, while the left hand is firmly held downwards upon the plate to steady it. This plate, with the nipper, is thus carried bodily backwards, laying bare the circular comb, which may then be turned into convenient positions for cleaning. The lips of the nipper jaws should be cleaned at the same time by running a hook along them, lest an accumulation of dirt should spoil their grip.

The nipper and tongue plate are brought back again into their normal positions by repeating the operation backwards in reverse order, great care being taken not to forget to replace the springs and to tighten the set screw which holds the nipper compression pin. Should this be forgotten, the pin will in all probability work out

and a smash occur. When the grid carrying the slivers is put down in place, the fringe of fibres which project from it must be pushed out between the jaws of the open nipper, care being taken that no loops are formed. The upper part of the feed grid opens on a hinge to facilitate the insertion of a set of new slivers. In closing it, care must be taken that none of the slivers are caught by the solid edges.

The comb segment may be removed from its shaft for repairs in the same position, the machine being turned until the fluted pressing-in roller is in its lowest position, and until the back screws holding the comb segment on its shaft are on top. These having been removed, the machine is again turned round into a convenient position for the removal of the other two screws, after which the segment may be slightly raised at one end and drawn towards the operator in order to free the other end, which is slightly sunk into the wheel driving the fluted presser-in. In replacing any of the comb bars in the segment after repairs, &c., the hackle setter must be very careful to see that all the screws are perfectly tight, and that none of the pin points project beyond or touch the straight edge of the apparatus provided with the machine for setting purposes. This point is of the greatest importance, since, if any points project beyond the prescribed circle, they are apt to touch the fluted presser-in or other organ, and, becoming hooked, hold the fibre and render it impossible for the brush to clear the comb when at work.

There are, as we have said, two lengths of feed, one of $\frac{1}{3}$ in. and one of $\frac{1}{2}$ in., producing a longer and shorter draft in the machine. If the amount of overlap remains the same the $\frac{1}{3}$ in. feed will produce a lighter sliver than the $\frac{1}{2}$ in. feed, and in any case gives less production, but gives the comb less to do. These two different feeds are produced by taking either four or five teeth every time upon the ratchet wheel on the fluted feed roller, it being

necessary at the same time to use corresponding cams back and front to give the nipper a corresponding motion. A change in the draft of the machine, by producing more or less overlap in splicing the combings, produces no change in the production of the machine. If more overlap is given, a shorter length of heavier sliver is produced in the same time. If less overlap be given a greater length of lighter sliver is produced.

The proper degree of overlap depends upon the length of the fibre, short fibre requiring more overlap and long fibre less. The amount of overlap is regulated upon the long-fibre comb by changing a pair of wheels, one of them compounded with the starwheel, which is intermittently driven by studs and friction rollers fixed in the side of the driving pulley, and the other upon the lower drawing-off roller, which is thus compelled to make more or less revolutions every stroke. If the driver is small and the driven wheel large, the drawing-off roller makes a comparatively smaller number of turns per stroke, draws forward a shorter length, and produces a longer overlap and *vice versa*. Since the centres of these two change wheels are fixed, they work in pairs, and must so be changed.

Four pairs of wheels are now supplied with the machine. The number of teeth they contain are as follows: 52 and 33, 55 and 30, 61 and 24, 67 and 18. The sum of the number of teeth in each pair is thus constant, *i.e.*, 85.

To start the machine when new or with fresh slivers the top feed roller is removed and the machine turned round, so that the nipper is in its lowest position and wide open ready for drawing-off to commence. Raise the fixed comb, give a half turn to the thumb screw which holds the feed gill down, so that the flat permits of it being raised.

In a like manner turn two screws, which allow the upper part of the feed grid to open on its hinges. Pass

the slivers straight and parallel without crossing them, and leave them so that they project about 2 in. from the grid, which should then be carefully closed, so that the outside slivers are not caught by the sides. Lower the feed gill, and give the thumb screw a half turn to hold it. Push the ends of the fibre through the open nipper, and turn the machine round by hand, so as to produce drawing-off. Lower the fixed comb, and put its spring in place. Then start the machine for a few strokes, drawing the fleece together and passing it through the trumpet mouth and condensing rollers to form a sliver. This having been satisfactorily accomplished, the machine may be started for good. When a can runs out behind it is important that no piecing be made in putting up another end. The end should be run in straight between the feed rollers and sandwiched between two others. The reason of this is that if the girls are allowed to make piecings they are sure to make hard piecings, which will cause breakages among the pins of the finer combs, which are often as closely set as 50 to 60 pins per inch. The machine may make 80 strokes per minute, and at this speed will produce more combed sliver and less noil than any other comb run with the same material. For dirty tows difficult to comb, and producing a large quantity of noil, it is advisable to use the $\frac{1}{3}$ in. feed, but the $\frac{1}{2}$ in. feed may be used for cleaner and more easily combed tows. As a general rule it is the quantity of noil which should govern the feed. The more noil there is in the tow, the lighter should be the feed, and *vice versa*.

The longest and best noil such as is produced upon some inferior combing machines may be recombed, while the shorter and inferior quality noil may be sold to felt and paper makers.

The ordinary combing machine is not suitable for recombing noils. Its minimum draft or draw-off is quite too long for such short fibre, and without sufficient overlap on the combings a level sliver cannot be produced.

The special short-fibre Delette comb should therefore be added to all tow-combing plants of sufficient importance upon which flax noils of sufficient length may be advantageously combed and a level sliver produced, which may be spun alone or mixed with others of longer staple at the back of a drawing frame.

The special short-fibre Delette tow comb differs from the ordinary machine, chiefly in the fact that the drawing-off rollers have a reciprocating motion given to them, so that while they make, say, three revolutions forward as the carriage advances, they make say, one backward, as the carriage rises towards the nipper, thus providing a sufficiently long tail end to form junction with the advancing fibres, and produce a level sliver. Otherwise the principles involved are exactly as in the larger machine. There is a slight difference, however, in the drive, since cone-friction clutches are employed instead of the star-wheel friction rollers to give motion to the drawing-off rollers.

The Delette comb for wool is very similar to those just described, being also made single-headed and in two sizes, one for wool from 2 in. to 10 in. in length, and the other for wool from 6 in. to 15 in. long, the production obtainable from the first being from 130 lb. to 220 lb. per day, and from the latter 175 lb. to 350 lb. A very similar machine is used for combing silk noils not exceeding 7 in. in length. It is to be noted that the Delette machine does not require the indiarubber drawing-off segment of the Heilmann and other machines, an organ expensive in first cost and upkeep, its place being taken by fluted drawing-off rollers, between which is an endless leather apron which carries the fleece forward to the trumpet mouth conductor and calender rollers.

CHAPTER V.

THE DELETTE-GRUN WOOL COMBER.

FIG. 31 shows another comb made by the same makers as the Delette comb. It represents the Delette-Grun 1907 comb, which now finds considerable use in France, Germany, and Spain for short wool, &c.

In this comb the front end of each tuft is combed out by means of a circular comb 6 in. in diameter, containing thirteen rows of pins and having a continuous rotary motion. As in the comb just described, the fibres are kept down in the pins of the comb circle by means of a fluted presser-in.

The tail-end of the tuft is pulled through the top or fixed comb, which is provided with a holding-up plate, similar to the tongue plate of the Delette machine in all but that it comes forward underneath the lower jaw of the nipper, as seen in fig. 32, and not between the jaws as in the Delette machine. The top comb is compounded with the feed gill, and moves backwards and forwards, with it to feed the slivers forward. The whole feeding mechanism, together with the fixed comb, comes close up to the drawing-off rollers while the latter are operating.

When combing short fibre, the yield of a combing machine of this sort depends upon the length of the front end of the tuft submitted to the action of the circular comb, and the length of the front end of the tuft depends upon the length of the nip or minimum distance between

the nippers or holders and the bight of the drawing-off rollers. In the Delette-Grun comb, this distance is about as short as it could be.

The reciprocating movements of the machine are short,

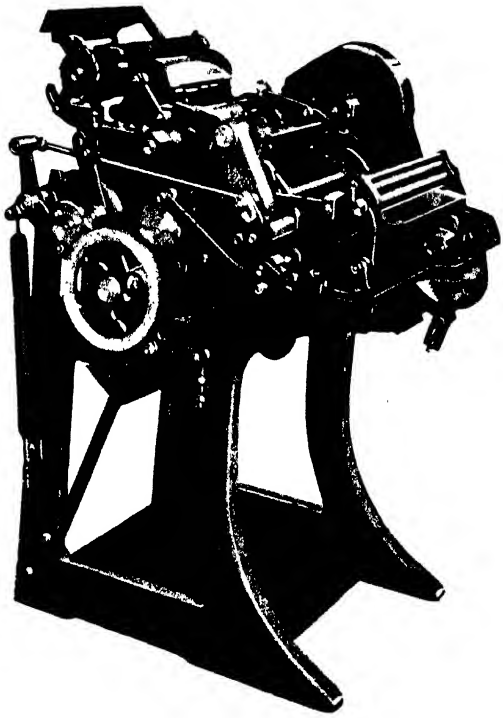


FIG. 31.

and hence wear and tear is reduced to a minimum. The turning centre of the circular comb has a fixed position, while the nipper or holder and feed mechanism has only a short backward and forward motion, firstly at the moment

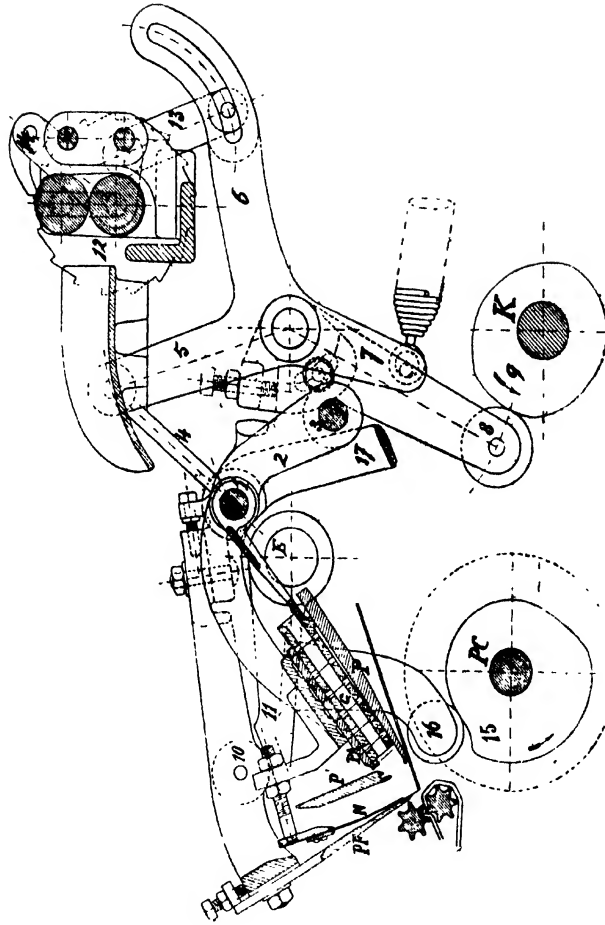


FIG. 32.

when it presents the front end of the tuft to the action of the circular comb, and secondly at the moment when drawing off commences, when it comes forward to present the combed out end of the tuft to the drawing-off rollers.

The drawing-off carriage has likewise a reciprocating backward and forward motion, backward to get close up to the nipper and fixed comb to commence drawing off, and then forward a short distance to leave room between the drawing-off rollers and top comb for the downward stroke of the sword or scythe which completes the drawing through of the tail end of the tuft.

The maximum length of staple which may be conveniently combed upon this machine depends upon the length the drawing-off rollers draw forward by their rotation, and upon the length of the stroke of the scythe, which may be regulated by shifting the point of attachment of a connecting rod in a slotted lever arm. With drawing-off rollers of the usual diameter and the maximum stroke of scythe, the length drawn forward is about 16 in.

The drawing-off rollers are driven by a toothed quadrant which has a reciprocating motion around its centre. The drawing-off rollers have thus a rotary backward motion, the length of which is regulated by the putting in and out of gear of a friction clutch by means of an adjustable eccentric. Thus the backward motion may be regulated for different lengths of staple so that a level and unclouded fleece of fibres is produced.

The superior production of the machine is due (1) to its width, 13 in. in the feed gill, 15 in. on comb, or 18 in. on leather apron; (2) to its speed of 95 to 100 strokes per minute; (3) to the progressive drawing-off arrangement. The latter result is due to the turning of the drawing-off rollers immediately the carriage moves towards the nipper, thus seizing the longest fibres in the front end of the tuft first. These fibres are thus *successively* drawn

through the fixed comb and not all at once, thus enabling the feed to be heavier than would be otherwise possible.

Fig. 32 shows the arrangement of the nippers or holders PP¹ of the top or fixed comb PF, and of the feed gill G-PA, in relation to the circular comb PC, but shows more particularly the method by means of which the feed grating G, the feed gill PA, and the fixed comb PF are given their backward and forward reciprocating motion, and by means of which the feed and fixed combs are raised at the right time.

It will be seen that the feed gill G-PA swings round the shaft 1 as a centre, as does also the fixed comb PF. This shaft 1 is carried by two arms 2 swinging on 3. Its position is partly controlled by the connecting rod 4, which couples it with the three-armed lever 5, 6, 7, compounded with the friction roller lever arm 8, resting upon the cam 9. It is the cam 9 then which gives the shaft 1 and the feed gill, &c., which it carries, their backward and forward motion, the feed grate sliding upon the lower jaw of the nipper and the fixed comb rolling upon its friction bowl 10 on a suitably inclined part of the lever 11.

The feed rollers furnish a length of slivers, equal to the forward motion of the feed gill, through motion communicated to the ratchet wheel 12 by the lever arm 6, the connecting rod 13, and the lever carrying the pawl 14.

The top comb is raised by the cam 15 fixed upon the shaft of the circular comb, and acting directly upon the bowl of the lever 16-11, swinging on the shaft E. When the top comb is thus raised it cleans itself against the cleaning blade N, rigidly attached to the feed gill.

As to the raising of the latter, it is produced by rotation around the shaft 1, brought about by the pressure of a cam (not shown in the figure) on the lever 17. The holding-up blade or tongue plate L, seen more clearly in fig. 35, is provided with the object of preventing any fibre from escaping the action of the top comb while the tail-end of the tuft is being drawn through the latter. While

drawing off is going on, it is consequently arranged to come close up to the pins of the top comb, as shown in figs. 32 and 33, but as soon as the nippers close and the comb segment is about to come round, it must be drawn back so that the front end of the next tuft may be combed. The blade L is pushed forward and drawn back by means of two levers 4 and 5 forming sides of a parallelogram. The lever 5 is provided with a slot by means of which the position of the blade L in relation to the fixed comb may be regulated. The other lever 4 can be regulated on an arm 7 linked to the screwed rod 8, which passes through a boss 9, itself linked to the lever 10. This lever is compounded with the lever 11, actuating the upper jaw of the nipper.

Owing to this arrangement, when the cam 13 raises 11, and consequently 10, the rod 8 acts through an arm 7, and draws back the holding-up blade L. When the nipper opens the reverse takes place, and the blade advances as the feed gill allows it to do so.

We saw before that the top comb advances with the feed gill. The holding-up blade is required to remain close to the comb all this time. For this reason the action of the lever 10 on the rod 8, producing the forward motion of the blade, is not direct, but is transmitted through a spring 14, which is compressed until the screw 15, carried by the arm 4, abuts against the arm 2 (figs. 32 and 33) of the feed grate. Contact under pressure is thus produced, so that the blade follows the feed mechanism as it advances.

As seen in figs. 32, 33, and 34 the holder or nipper is composed of the lower jaw P and the upper jaw P^1.

The former only makes a slight movement in taking up the position which it occupies in fig. 34; that is to say, as close as possible to the circular comb and corresponding, at the period when the front end of the tuft is being combed, to its position in fig. 33, while drawing off is taking place. This motion is given it by the cam 1 acting

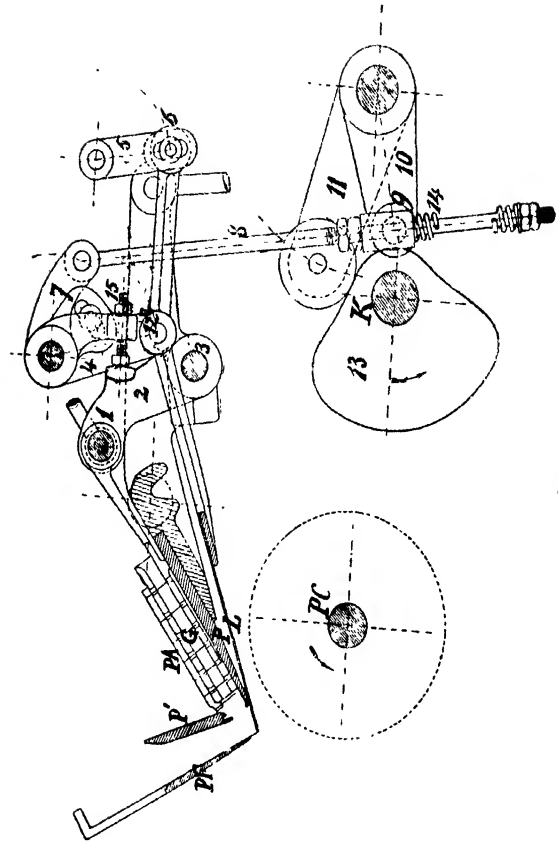


FIG. 33.

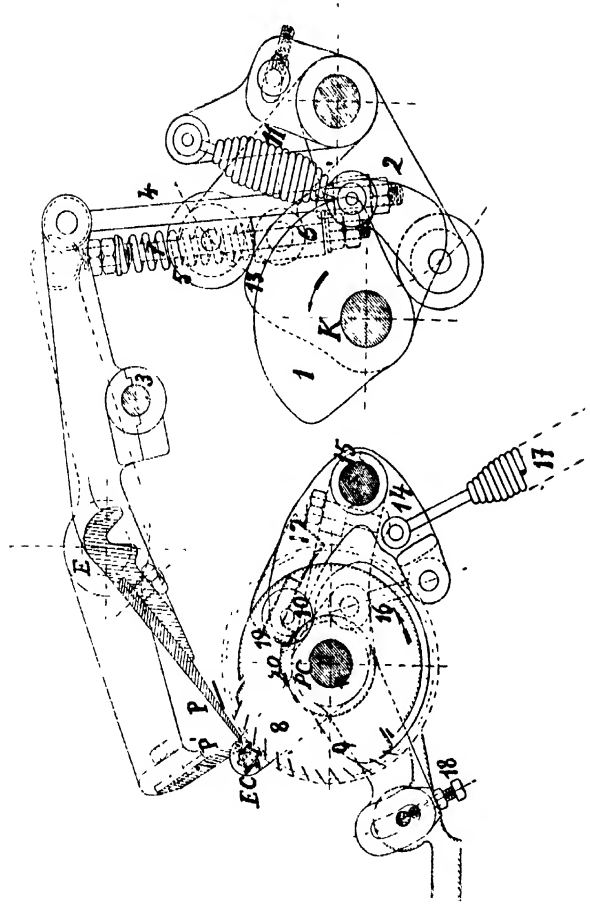


FIG. 34.

on the lever 2, which is connected by the rod 4 to the tail-end of the lower jaw P of the nipper. The upper jaw of the nipper is only given an up and down motion, opening and closing down upon the lower jaw.

It is actuated in a similar manner to the lower jaw. The cam 13 acts upon the lever 11 connected by a rod 5 to the tail-end of the upper nipper jaw pivoting around E. However, in order to produce the pressure between the jaws necessary to hold the material, the rod 5, instead of being simply linked to the lever 11, passes through a boss 6 linked to this lever, and communicates the motion of the latter, not directly, but through a spring 7, which is compressed and produces pressure as soon as the two jaws come into firm contact.

The fluted pressing-in roller which rides over the pins of the circular comb to keep the fibre down while being combed, has two motions, firstly, a rotary motion produced through a pinion driven directly by a wheel fixed upon the axle of the circular comb, and, secondly, a periodic oscillating motion around the axis of the circular comb as a centre, and produced in the following manner:—

The fluted presser-in is carried by two arms 8 free to move around the circular comb spindle. Upon this latter is fixed a cam, which acts upon the friction bowl 10 of a two-armed lever 12-14 swinging upon a fixed stud 15, and of which the arm 14 is linked by the rod 16 to the prolongation of one of the arms 8. The action of the spring 17 assures the contact of the friction roller 10 with its cam.

The setting of the position of the presser-in in relation to the nipper depends upon the position of the shaft 15, the supports of this latter swung upon the circular comb shaft, being adjustable by means of a screw 18.

It is when the finest rows of pins of the circular comb are passing through the material being combed that the presser-in should be most in evidence. The latter there-

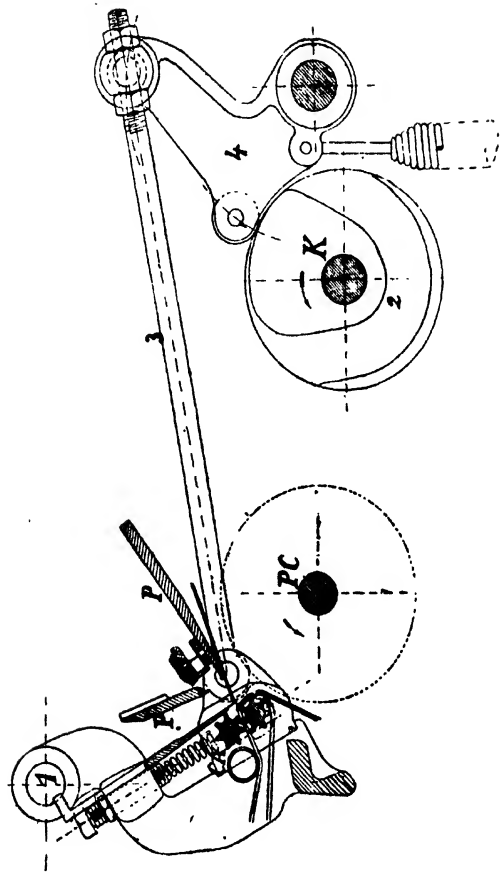


FIG. 35.

fore comes up close to the nipper with a quick jump, which causes the fibres to be pinned close up to the holder.

In order that the fluted presser-in may approach the nipper as close as possible, one of the flutes is quite shallow, as seen in fig. 34. The quick jump referred to is

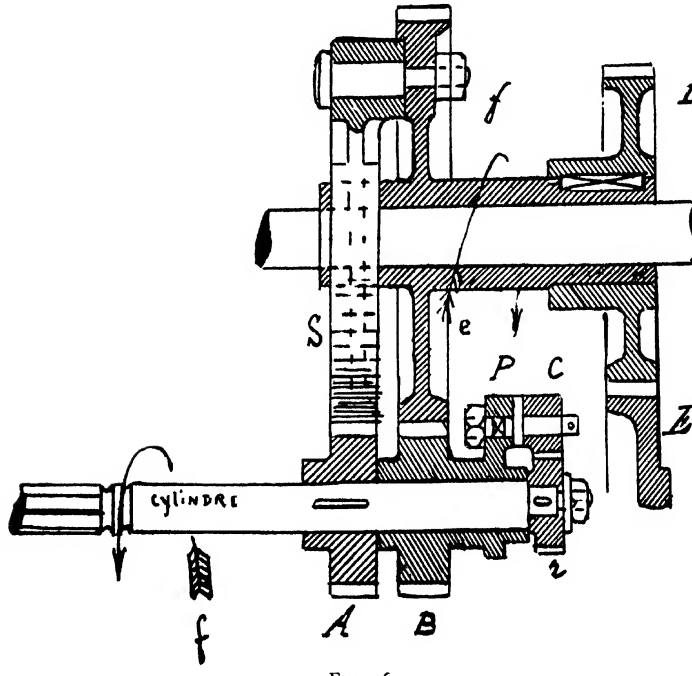


FIG. 36.

obtained by means of a supplementary lever 19 (shown by dotted lines) lying directly on its square end, and not by a friction roller on its cam 20, the outline of which is abrupt and placed in such a position as regards the cam 9 that the former comes into action at a prearranged moment, and substituting its motion for that of the cam 9,

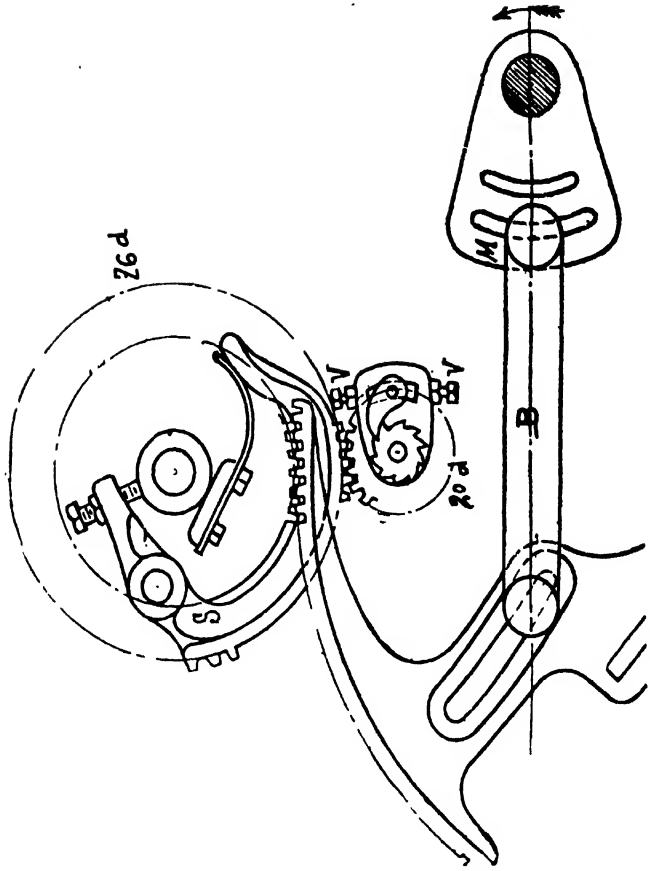


FIG. 37

produces a sharp displacement of the presser-in such as could not be produced by the ordinary cam and friction roller.

The drawing-off rollers CA, as seen in fig. 35, are carried by a carriage movable around the shaft 1. Upon the cam shaft K are keyed two cams, one partly flanged, each lifting one side of the carriage by means of levers 4 and connecting rods 3.

The drawing-off rollers are driven as follows: Upon the lower drawing-off roller are keyed a wheel A of 20 teeth and the ratchet wheel *r* of 10 teeth, the wheel of 20 teeth B being loose and compounded with a face-plate P carrying the pawl C, which engages the ratchet wheel *r*, all shown in fig. 36.

The wheel B produces the forward drawing-off motion, and the wheel A the backward motion necessary to bring back a long enough tail-end for splicing up.

The wheel B gears with another of 76 teeth C. Upon the pap of C is keyed the wheel D, gearing into the sector E. This latter is actuated by a crank M keyed upon the end of the cam shaft. The connecting rod B links the quadrant E to the crank M. The reciprocating motion of the quadrant, which can be varied by altering the point of attachment of the connecting rod in the slot of the quadrant, is transmitted to the drawing-off rollers, first, for drawing off by the wheels D, C, B, the pawl C, and the ratchet *r*, rotation taking place in the direction of the arrows *f*. Secondly, for turning back the direction of the rotation is reversed, the pawl slipping over the backs of the teeth of the ratchet wheel *r* without effect. It is a toothed quadrant S, bolted to the wheel C and gearing into A, which produces this backward motion, the extent of which depends upon the length of this sector, and when it ceases to gear, for when it passes out of gear the rollers cease to turn.

In order that this arrangement may work properly, it is necessary that the teeth of the wheels A and B are in

line when the pawl is pushing the ratchet. That this may be so, the position of the pawl is adjustable by two screws V V, fig. 37. The same thing applies to the teeth of the wheel C and the toothed segment S, which should also be in line.

Thus, recapitulating, while the rollers are drawing off and being driven by the ratchet and pawl, the quadrant S turns with the wheel C and gears at a given moment with the wheel A, but without producing any effect. It is not until the direction of rotation changes that the influence of the sector S makes itself felt and communicates to the drawing-off rollers a backward motion, the duration of which can be varied by altering the length of time the sector gears with its pinion A.

The blade CF, fig. 38, holds up the material into the fixed comb, while the sword strikes downwards to complete the drawing through of the tail-end of the tuft. It is pushed backwards by the drawing-off rollers at the moment when they come close up to the nipper, coming forward again under the action of the spring 1, pivoting around the centre 2 at the same time as it is raised by the cam 3, so that it takes up a position against the fixed comb.

The sword or scythe blade is actuated by a cam 4, the lever 5 and the connecting rod 6 acting upon the lever 7, the slot in which permits of the length of stroke being regulated.

Grun's French Wool Comb, 1913 pattern, is distinguished mechanically by its strength, simplicity, and facilities for easy setting, and as a comb by its production of perfectly combed out sliver.

The more or less perfect cleaning accomplished by a comb depends essentially on the choice of the relative positions of the nippers and circular comb, so that the front end of the tuft may be struck by the latter at the most favourable angle.

In this respect the superiority of the old Meunier Grun

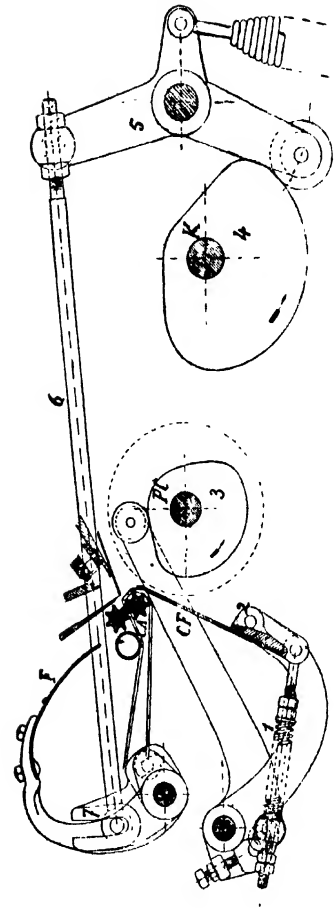


FIG. 38.

comb has been recognized, which comb, without any special presser-in, cleans out the material in a manner unequalled by machines which have succeeded it and provided with pressers-in and more rows of combs.

The Grun 1913 comb is thus practically a Meunier comb fitted with the latest improvements to obtain increased production and yield sliver well spliced and level, and to increase the scope of the comb as regards length and quality of material combed. This comb will work fibre up to 12 in. in length. Its working width is about 13 in.

CHAPTER VI.

THE SCHLUMBERGER COMB.

Until the advent of the Delette comb, which we have just described, the Schlumberger comb was practically the only one used by flax tow combers. The results obtained by its use are quite good, but it has been found that its producing powers are not equal to those of the Delette machine, and also that larger percentages of noil are made.

The Schlumberger comb, as used for wool and flax tow, is of the true Heilmann type, the machine being, however, made single-headed and the parts larger and stronger in correspondence with the length and nature of the fibre to be combed. Fig. 39 gives a general view of the machine as used for flax tow, while fig. 40 shows more clearly the general arrangement of its parts.

The machine is fed by 15 slivers, which, passing over the sliver guides and the back plate and under the pressure roller A, are introduced into the feed grid or gill B, which pushes them forward at intervals through the open jaws of the nipper. The feed grid is double, consisting of two smoothly polished brass grids, into which project the pins of the gill. When the nip is closed, the feed gill being lifted, the grid moves backwards for a fresh length of sliver, and then the gill descends so that the pins penetrate the sliver, and, the nipper then opening, the slivers are pushed forward by the descending grid, when the nipper

C again closes and holds the tuft fast until it has been combed out by the comb segment D of the revolving cylinder E. The jaws of the nipper are fluted, the upper one being in addition shod with leather or rubber to ensure that the material is tightly held while it is being

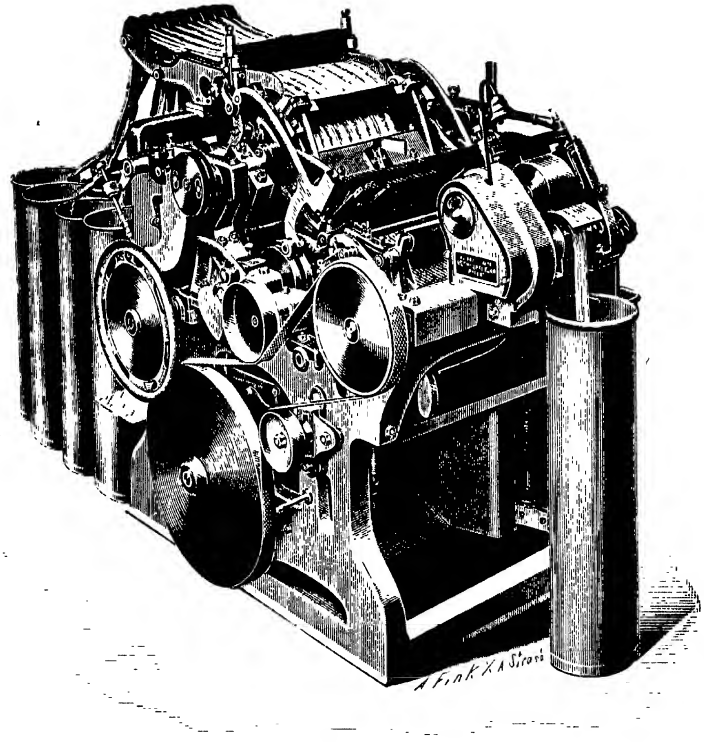


FIG. 39.

combed. The passage of the comb segment through the end of the tuft held by the nipper causes the short fibre or noil to be carried away and deposited upon a circular brush F, which in turn deposits the noil on the doffer roller G, from which it is stripped as a broad band or

fleece by a vibrating doffer comb, falling into a box placed underneath. Particles of straw and other impurities are expelled by the brush G and thrown into another box behind. When the front end of the tuft of fibres has been combed by the comb segment the top comb H comes down and penetrates the tuft, under which the india-rubber or leather-covered segment K of the cylinder has by this time arrived. Simultaneously the back carrying roller L of the leather apron has been raised together with a roller lying upon it, and as the former is pressed against the drawing-off roller M, fig. 40, which is turned round by frictional contact with the drawing-off segment, they seize hold of the front end of the tuft. At this instant the jaws of the nipper open and the tuft is released, its tail end being combed out in its passage through the fixed comb H. The noil left in the fixed comb remains hanging on to the front end of the next tuft, and is removed when the comb circle comes round again, the latter also combing out again the tail end of the previous tuft protruding under the drawing-off roller. The combed tufts overlap each other as they are delivered on to the leather apron, and are formed into a fleece, which is condensed by a trumpet-mouthed conductor into a sliver, which is compressed by calender rollers and delivered into a can.

Fig. 40 also shows the brush and doffer mechanism for clearing the circular comb of noil. The brush is raised into contact with the comb segment at the proper moment by means of a cam, and as soon as the pins have passed the brush the latter drops down slightly, so that the hair may not touch the drawing-off segment, lest it cause it to be rough and hold the fibres instead of passing them on freely to the drawing-off rollers. The fillet roller or doffer must not be set too close to the brush or the noil will be beaten into "naps," and not delivered in an open condition. The surface speed of the brush is nearly five times that of the comb cylinder. At the point of contact it runs in the same direction as the comb cylinder, so that

it overtakes and passes the comb pins and brushes the fibres up from the base to the points and removes them entirely. The doffing knife makes about 450 vibrations per minute.

The dropping of the top, intersecting, or fixed comb H in the right place and at the right moment is most important. This comb must be in position before the drawing-off roller and segment begin to draw the fibres through the open nippers. Since the pins of the circular comb must clear the lower jaw of the nipper, there must of necessity be a short length of slivers in front of the bight of the nipper jaws, which is not combed by the circular comb. The fixed comb, therefore, must fall at such a distance in front of the nip as to ensure that this uncombed portion will have to pass through its teeth in being drawn off. With long fibre it is not necessary to set the fixed comb as close as when the fibre is short, in which latter case greater accuracy is required. The top comb has the same backward and forward motion as the feed gill, drawing-off commencing when the top comb is in its rearmost position, so that long fibres get into the nip without being bent. As drawing-off continues the top comb gradually moves down towards the roller M until it is as close as possible without actually touching.

The principal motions of the comb are derived almost entirely from a series of tappets or cams arranged upon two shafts, the cam or main shaft and the comb cylinder shaft. The main shaft carries the fast and loose driving pulleys and a wheel of 120 teeth. Compounded with this latter wheel is a shell tappet, in which works the end of a lever controlling the amount of forward motion of the leather delivery apron and the rollers which carry it. By the combined action of tappets the brush is raised and lowered in and out of contact with the comb circle. One tappet controls the motion of the feed rollers and feed gill through levers, another lifts the feed gill, while a third raises and lowers the drawing-off roller upon

the drawing-off segment. The cams upon the comb cylinder shaft give the drawing-off roller its backward and forward motion. Bevel wheels convey motion to the fillet roller or doffer. The hand wheel is compounded with a shell tappet, which raises and lets fall the upper jaw of the nipper. The wheel upon the comb cylinder shaft has a like number of teeth to the wheel upon the cam shaft, hence both the main and cylinder shafts revolve at the same speed. The tappet upon the cylinder shaft compounded with the former produces the backward and forward motion of the leather apron and nip rollers, bringing the drawing-off rollers up into position and producing the requisite nips with the drawing-off roller M. A tappet raises and lets descend the top comb, while a disc acts as a stop to prevent the comb coming down too far. A plate on the end of the cylinder shaft has a crank pin on the outside. In the comb as made for wool, this gives motion to the calender rollers through which the sliver is delivered into a can. Upon the inside of this plate are two pins working intermittently in a notched plate. This plate gives a rapid rotary motion to a small perforated roller X, which revolves just in front of the comb cylinder, and whose function is to brush upwards quite close to the drawing-off segment and detach the fibres from the surface of the latter as they come through the nip of the drawing-off roller and direct them up into the second nip, or that between the leather sheet roller and the drawing-off roller. The long arms N, which carry the top comb, are pivoted upon a centre A. The feed rollers O participate in the backward and forward motion of the feed gill. A cam causes the drawing back of the feed gill and other organs which move with it, the return or forward motion being caused by a spring. The rise and fall of the upper portion of the feed gill is controlled by a tappet upon the main or cam shaft. It is necessary to key this tappet on its shaft in such a position that its action takes place immediately after the

nip has closed and before the other tappet commences to move the feed gill backwards. The feed gill arms must, furthermore, be kept in their raised position until the backward motion is completed, when the upper plate drops back by its own weight into its proper position and causes the pins to pierce the slivers in the feed gill and hold them firmly during the forward feed.

The upper plate of the feed gill can be swung back on its centre by hand when it is desired to pass in fresh slivers or to withdraw those already in the comb. In the same way the arms N carrying the top or fixed comb can also be swung back on their centres O when it is desired to raise it by hand for examination or cleaning purposes.

The top or fixed comb is given its short up-and-down motion by a tappet upon the comb cylinder shaft, a friction bowl upon the extremity of a short downward arm attached to the top comb frame working on top of the tappet. A somewhat similar downward arm is adjustably attached to the other end of the fixed comb, and acts as a stop finger, coming down on a circular disc on the comb cylinder shaft and preventing any possibility of the comb descending too low and coming into contact with the drawing-off segment.

The lower jaw of the nipper, upon the ends of which the feed gill slides backwards and forwards, is screwed to a casting supported by a spring, which gives slightly when the upper jaw comes into contact with it.

The feed rollers A are pressed together by pressure applied through a V-shaped saddle piece, bent bolt, spring and nut. A pawl or detent centred in a lug on the casting engages with a small ratchet wheel on the right-hand side of the bottom feed roller. The casting being stationary while the feed gill is moving backwards, the pawl holds the teeth of the ratchet wheel and so causes the bottom feed roller and the top roller A upon it to revolve and thus roll back upon the slivers without disturbing their position.

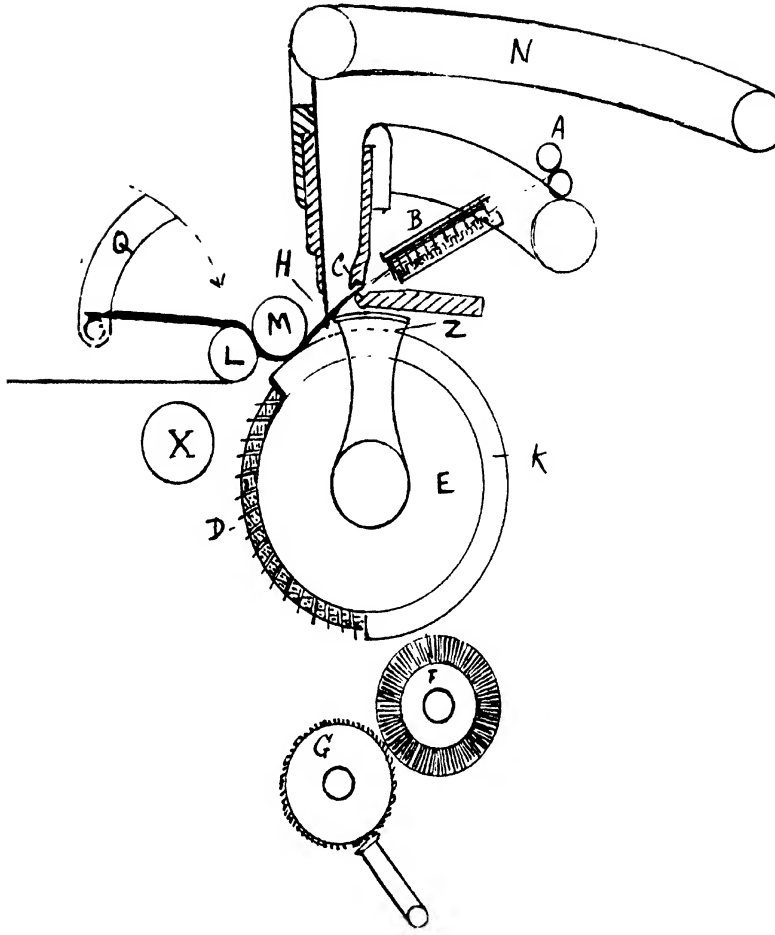


FIG. 40

The holding-up blade Z, shown under the feed gill and nipper in fig. 40, is applied to the Schlumberger comb as arranged for tow, and moves forward between the lower jaw of the nipper and the comb cylinder to push the tuft of fibre which has been combed well forward towards the intersecting comb and the drawing-off roller as the nip opens, and also to hold the fibre well up into the pins of the fixed comb.

In combing very short material the upper jaw of the nipper must come well down and as near as possible to the pins of the circular comb without touching them.

The lower nipper jaw V is screwed to a casting which is in turn bolted to another, the two together swinging on the same centre as the upper jaw. Each of these castings has a downward projecting leg terminating in an adjustable set screw, which works against a projecting lug or stop on the spring box bolted to the framework of the machine. This arrangement is necessary to prevent the fibre being cut by the closing nipper jaws. The pressure between the upper and lower jaw of the nipper is regulated by the degree of initial compression of the spring in the spring box by the set screw in the end of the box. When the upper jaw descends upon the lower one the spring is compressed still further, and considerable holding pressure produced. The upward motion of the lower jaw of the nipper when the latter opens is regulated by adjusting the set screw which comes in contact with the stop.

A strong spiral spring keeps the friction bowl in contact with the tappet which closes the nipper jaws, and the same spring lifts the upper nipper jaw when it is released by the tappet.

Fig. 40 shows how the top or fixed comb H is bolted to the cross piece N carried on the arms. As in other combs, the pins of the fixed comb and circular comb slips are soldered to strips of metal which form their foundation. By means of set screws the height of the comb can

be very accurately adjusted and levelled so as to come down and pierce the fringe of the fibres protruding from the nip without touching the drawing-off segment. A row of bristles is fastened to the comb carrier by means of screws in slotted holes. This brush, besides helping to keep the drawing-off roller clean, also tends to press the fibre down into the nip of the drawing-off roller.

As in the Delette comb, the comb segment or circular comb is built up of rows of pins each screwed independently to the segment, and the segment itself is easily screwed fast to and detached from the cylinder, so that it can be readily replaced if damaged. To refill or repair the comb slips they are placed in metal "books," part of which are drilled or grooved so many per inch to receive the pins, which, when in position, are soldered to the slip while clamped in the book. When the job is completed and the book opened, the pins are firmly fixed and evenly spaced.

In the wool comb the drawing-off segment is leather covered, the leather passing round the ends of the segment and being made fast to clamps on the inside. These clamps can be drawn inwards by means of nuts and bolts, so that the leather is evenly and highly stretched.

A pair of upright castings carry the drawing-off roller. When these castings oscillate they give the drawing-off roller a corresponding motion.

In this way the tappet directly controls the upward motion of the drawing-off roller, which takes place just before the first row of pins of the comb circle comes under the nipper. The tappet is keyed upon its shaft in such a position that it releases the lever quickly, just after the top comb drops or at the same moment. Springs pull the drawing-off roller sharply down upon the drawing-off segment, so that a nip is formed. The springs are fixed to the lower portion of the framework at the rear of the machine by winged nuts. By means of these nuts the pressure of the roller upon the segment may be adjusted.

The pull of these springs causes a tendency to a constant forward motion of the drawing-off roller. This forward motion is, however, controlled by tappets on the comb cylinder shaft working against friction rollers. The position of these friction rollers is adjustable in slots, so that the top comb and drawing-off roller may be set to each other.

As previously explained, the forward motion of the feed gill takes place shortly after the nippers open, so as to offer a fresh tuft of fibres to the action of the comb cylinder. We also saw how the top comb is moved forward with the feed gill, so as to avoid the accumulation of fibre between these two organs. The drawing-off roller must also move forward by a like amount.

As previously explained, the forward motion of the drawing-off roller is controlled by tappets on the comb cylinder shaft, the shape of these tappets being such that when the feed gill moves forward the friction bowls are allowed to move in, and the pull of the springs keeps them tight against the tappets as well as pressing the roller against the drawing-off segment.

There should be a little play between the levers and the tappet on the main shaft when the motion is released; that is to say, the tappet should give latitude for a greater amount of downward movement than is actually required, so that the weight of the castings, together with the pull of the springs, may be wholly carried by the pressure of the drawing-off roller upon the drawing-off segment; or, otherwise stated, the downward movement of the drawing-off roller should be stopped by the drawing-off segment before it gets as far as the tappet would permit it to go. The amount of this play can be regulated by adjusting screws in the lower portions of the castings.

An important factor as regards the length of overlap of succeeding tufts of fibre in splicing up with the tail end of the preceding tuft is the amount of traverse given to the leather apron by a picking motion, which causes

the front wooden roller carrying the leather apron to move forward a certain amount for each stroke of the comb, and therefore to draw the sliver and apron forward a greater or a less degree according to the length of the staple being combed.

There is on the end of the comb cylinder shaft, on the left-hand side of the machine as constructed for wool combing, a disc plate. A stud on this plate forms a crank, which operates the press roller picking motion through a connecting rod. Upon the inner side of the plate is a semi-circular cam piece and two studs, which engage with a star wheel in such a way that while the cam is in contact with the star wheel the latter is locked fast, owing to the cam engaging with one of the dishes or hollowed faces of the star. When, however, one of the pins comes round it engages with a slot in the star wheel and carries the latter round until the pin slides out of the slot. By this time, however, the second pin has got into the next slot, and keeps up the motion until it also is forced to leave its slot. In this way the star wheel is given an intermittent motion for every stroke of the comb. The toothed spur wheel is compounded with the star wheel, and gears with the pinion on the end of the beater shaft, so that this shaft is given a quick intermittent motion by the star wheel. Upon this beater shaft are a number of blades set radially, or a perforated roller, which come close up to the drawing-off segment, and, moving in an opposite direction at the point of near approach, create an upward draught of air, which detaches any fibres which have a tendency to stick to the drawing-off segment, and lifts them up into the second nip.

To adjust the beater roller its bearings are carried on the pedestal cap of the comb cylinder bearing and clamped fast by a bolt to this cap after being raised or lowered by means of a locking set screw.

The ratio of combed sliver to noil can be varied on this comb within certain limits by adjusting the working parts

so that all fibres below a certain length pass into the noil. If only the shortest fibres are removed a greater proportion of combed sliver of course results, the ratio decreasing with the longer adjustment.

The following rules have been given for setting the Schlumberger flax tow comber of variable pitch.

By means of two large removable hand levers applied to the quadrants in the racks of the movable part of the large supports, the centre of the nipper can be made to take three positions or different pitches in connection with the combing cylinder, viz., pitches A, B, and C.

The pitch A is the smallest. The pitch B is obtained by inserting a block $7\frac{1}{2}$ mm., or nearly $\frac{1}{3}$ in., thick between the fixed part and the movable part of the large supports. The pitch C is obtained in a like manner by inserting a block 15 mm., or $\frac{3}{5}$ in., thick between the same parts. A nipper cam marked A, B, or C corresponds to each pitch or position. Every nipper cam has marks on its circumference, viz., 0, 1, 2, 3, and 4, which serve, by means of a pointer fixed on the framework, to place the machine in five different positions to proceed with the setting of its parts.

To alter the reach from A to C or from C to A, take away the cover and turn the machine until the tenth row of combs is under the nipper, *i.e.*, position 2; then take off the feed gill lever and place the friction roller in the hole A or C. Turn the machine round until the friction roller in the nipper lever is in a descending position. Relieve the pressure upon the nipper springs and change the fixed comb stops A to C or *vice versa*. Slacken the set screws in the bracket marked 25c. Open the screw of the belt fork, and alter the set screw of the top comb lifting lever. Remove the nipper cam. Replace the feed gill lever and springs. Slacken the set screws in the shifting brackets. Remove the reach blocks and tighten the bolt in the shifting bracket. Put the friction roller on the nipper lever in position 0. Slacken the regulating

set screw for the lower jaw of the nipper. Put on nipper cam A or C as the case may be. Put in position O and regulate the top edge of the lower jaw of the nipper to 11 mm. or 12 mm. from the surface of the rubber segment. Tighten the set screws. Regulate the pressure between the nipper jaws. Turn the machine until the nippers are just closed, and set the striker by means of the connecting rod. Lift the lower jaw of the nipper by the set screw until it is 1½ mm. clear of the pin points.

In the position A the detaching roller, 45 mm. in diameter, is generally placed at a distance of 32 mm. from the nip of the cushion plate, which is at a distance of 50 mm. from the point of contact of the roller on the rubber segment. This distance can be increased to 60 mm. by the movement of the friction rollers in the slots of the detaching levers. The ends of the fibre can thus be combed to different lengths according to the nature of the material being treated, in going from the distance of 50 mm., or 2 in., to 60 + 15 = 75 mm. = 3 in. by millimetre to millimetre.

We will enumerate in their order the points from 0 to 4, and for each one the corresponding positions of the parts, and the manner in which to regulate them.

For each change of pitch from A to B or C, also change the position of the roller of the feeding carriage and of the feed gill in the holes A, B, and C.

Point 0.—The 0's on the wheels with 120 teeth must coincide on the line joining their centres. The endless leather or apron is in its nearest position to the rubber-segment. Set it at ½ mm. from the segment and at 1 mm. from the detaching roller. The fluted pressing roller of the endless leather apron must be set at 1½ mm. from the detaching roller. Put sufficient pressure upon this roller to hold the fibre firmly when it is caught in the point of contact.

In this position the cleaning brush for the top comb must not have more than ½ mm. play. It must not project

downwards beyond the root of the pins, which are thus left clear.

Point 1.—The nip is open. Put a little pressure on the spring of the cushion plate, so that the regulating screws come against the stops. Regulate the lower jaw to a height of 12 mm., 14 mm., or 17 mm. above the rubber segment for the pitch and nipper cams A, B, and C respectively. Put pressure on the cushion plate until the cup lever, provided for the purpose, with a weight of 8 kilos, or 17½ lb., is in equilibrium at both sides by the tension of the springs. The feed is at the end of its traverse towards the detaching roller. The runner of the feed lever is in the hollow part of the cam. Set the feeding arms perfectly parallel, so that the slide can move in this position without moving the feeding carriage. Observe a distance of 1½ mm. between the feed gill and the upper jaw of the nipper. The feed gill must be pressed into the material by means of the intermediate spring compressed 3 mm. to 5 mm., according to the nature of the material being treated. More pressure is needed for fine close flax tow than for Russian fibre, for instance. The fixed comb is set at ½ mm. from the detaching roller, and must be parallel to it. The holding-up blade of the fixed comb must be 1½ mm. behind the pins of the latter.

In this position also set the brush ½ mm. clear of the doffer and 4 mm. or 5 mm. into the pins of the segment.

Point 2.—Set the edge of the upper jaw of the nipper 2 mm. from the points of the pins in the circular comb, the tenth row of which is under the closed nipper. Do not regulate before the middle of the segment, because the closed nipper gradually approaches the circular comb and does not reach its nearest position until the seventh row is under it. The brush which is attached to the upper jaw should penetrate 1 mm. into the segment of combs. The brush which cleans the fixed comb should just touch the pins of the circular comb. The roller of the feed gill lever is on the highest concentric part of

the cam, and the pins of the gills in the feed grating should be entirely out of the material before the backward movement of the carriage. The stroke of the feeding mechanism is varied from 8 mm. to 18 mm. by moving the sliding block in the slot in the feeding arm. This slot is graduated 8 to 18. Position 8 causes the pawl to take the tooth of a ratchet wheel of 16 teeth, and produces a feed of approximately 8 mm., other positions giving correspondingly longer feeds, one tooth on ratchet wheels of 9 to 14 teeth being taken, and 2 teeth on ratchet wheels of 14 and 16 teeth for 18 and 16 mm. feeds.

In position 2 also regulate the knife to clear the leather sheet and the fluted pressing roller.

Point 3.—Adjust the length of the connecting rod attaching the shield with the arm of the nipper, so that the shoulder of this connecting rod is on the point of leaving the oscillating slide. From this moment the shield follows the forward movement of the feeding carriage. The setting of the projection on the feeding spindle by means of the set screw permits the stroke of the shield to be advanced or retarded.

Point 4.—The detaching roller falls on the rubber segment at 5 mm. from the beginning of the cast-iron shell, and in reach A is 37 mm. distant from the lower jaw of the nipper. If the pitch be increased the position of the detaching roller must be altered by moving the runner in the slot of the three-armed axle towards the centre of that axle, so that it always falls at the same place on the segment. Tighten each of the springs by giving about twelve turns to put a pressure on the detaching roller. The runner of the tree-armed axle rests on the cam, and the set screws must be regulated to touch the oscillating supports of the detaching levers without pressure. At point 4 the leather apron is in its furthest position from the detaching roller.

To change the position of the detaching roller, the position of the rollers in the upper part of the detaching

levers must be altered, this necessitating a fresh adjustment of the endless leather every time.

In increasing the pitch of $7\frac{1}{2}$ mm. or 15 mm. from the centre of the nipper, do not touch the mechanism which forms the sliver. The pawl should touch the tooth of the ratchet which moves the leather apron. The fixed comb is at the end of its stroke, and its pins should be $1\frac{1}{2}$ mm. from the segment.

In position 4 slacken the bolt holding the apron cam in place. Complete a turn of the comb to position 4 again and set the cam so that the ratchet wheel is bearing against the pawl. If the lead is not sufficient, move the friction roller nearer the end of its slot. In this position also regulate the knife to clear the drawing-off roller and rubber.

Brush and Doffer: The brush should graze the pins of the doffer and penetrate 4 mm. into the pins of the circular comb.

The doffing knife should be set $\frac{1}{4}$ mm. from the doffer. Regulate its stroke by the forked lever in such a way that its stroke will be longer in front than behind the line joining the centres of the doffer and knife.

It is to be noted that the Schlumberger comb is provided with a sword or scythe fulfilling the same functions as that on the Delette machine. There is also a ratchet wheel and pawl by means of which the travel of the leather apron can be augmented by the amount necessary to just leave sufficient overlap in splicing up the tufts.

The Schlumberger wool comb, 1883 improved pattern, has been largely used on the Continent during the last few years.

The slivers from the bobbins of sliver placed in the creil behind the machine, first pass under a wooden guide rod, then rise over a cast iron plate in which are sixteen eyeholes through which the slivers pass into the feed gill of the machine.

Below the feed gill is the nipper, composed of an iron

and upper and lower jaw with ribbed lips fitting into each other when closed.

The upper jaw is covered with rubber and leather in order to hold the slivers firmly right across its face. Close in front of the nipper is the fixed or top comb which with pins pointing downwards when it descends penetrates the slivers issuing from the nipper. In the centre of the machine is a shaft with a cast iron cylinder upon it. Upon the face of the latter are screwed two segments, one the comb segment and the other the drawing-off segment. Some combs are double nip combs or have two drawing-off and two comb segments on the same cylinder. Below the comb circle is a circular brush which clears the noil off the comb circle pins each time they pass. The brush is itself cleared by a doffer upon which it deposits its noil, while the doffer is cleared by a quick-running doffing knife.

A cam shaft controls the drawing-off rollers and raises and lowers them. In this comb the nipper remains stationary while the feed is produced by the reciprocating feed gill which makes a backward movement open, then closes and brings forward a fresh length of sliver through the open nipper The nipper then closes, the fixed comb rises, and the drawing-off rollers recede. The nipper firmly closed, the first row of pins of the circular comb pass through the fringe of fibres protruding from and held by the nipper, and when the whole segment has passed the fibres lie upon the drawing-off segment when it comes round. At this moment the fixed comb descends as near to the nipper as possible. Then the drawing-off rollers advance and catch the point of the combed end of the tuft and as the nipper is opening the tail end of the tuft is pulled forward through the fixed comb and the whole tuft is deposited upon the endless leather apron which is found at the delivery side of the machine. Immediately the feed gill brings down more fibres between the nipper jaws and the cycle of operations is repeated, the next tuft

being added to and spliced up with the preceding one on the leather apron, a continuous fleece of combed fibres being thus formed, which being passed through a trumpet mouth and two plain calender rollers is delivered as a sliver.

Owing to the high surface speed of the brush, dirt, &c., is separated from the noil and thrown by centrifugal force into a special receptacle at the rear of the machine.

This machine usually makes from 95 to 120 strokes per minute.

Setting the Comb.—The cams which produce the drawing-off and actuate the pressing levers are keyed upon the cam shaft and must be carefully set so that they bring down the drawing-off roller at the proper time upon the drawing-off segment. The point at which they should come in contact corresponds with the first screw on the surface of the drawing-off segment. If the rollers touch the segment too soon, the segment must be advanced and *vice versa*. The circle is advanced or retired by means of an adjustable pinion on the right side of the cylinder, thus —The intermediate wheel gearing with this pinion is taken off and the two set screws slackened and the cylinder advanced or drawn back by the adjusting screw provided. The set screws are then tightened up again.

The nipper must next be set to open and shut at the right time and to come down close enough to the comb circle. The nipper must be $\frac{1}{8}$ in. open when the drawing-off rollers touch the drawing-off segment.

The opening and closing of the nipper is done by a cam wheel placed on the cam shaft. The friction roller of the nipper lever works in the eccentric groove in the side of this wheel. If this wheel is turned back a little, the arrival of the highest point of the eccentric is delayed and the nipper opens later. If, on the contrary, the wheel is turned forward a little, the nipper opens sooner. The nipper should descend to within $\frac{1}{32}$ in. of the points of the pins of the comb circle, so that the tuft of fibre may

be thoroughly combed, but it must not touch, lest the pin points be damaged.

The position of the nipper is regulated by a screw on the nipper lever as follows: The two set screws which hold this lever on the nipper shaft are first slackened. Then if the regulating screw is turned forward the nipper goes lower, and *vice versa*. The nipper should also be set so that when shut there is only in. play. The feed gill and fixed comb must then be set. The cams which give them their two movements are placed on the comb cylinder shaft. The cam of the fixed comb is to the left of that for the feed gill to the right. When the drawing-off rollers grip the front end of the tuft the fixed comb must fall and the feed gill be shut so that no uncombed fibres may be drawn through by the others. As soon as the drawing-off rollers move forward the fixed comb rises, and the feed gill advances with fresh material upon which the nipper then closes. At the same moment the feed gill opens and the whole feed gill moves back to close upon a fresh part of the slivers.

As we have already said, the fixed comb is actuated by a cam, which may be regulated upon its spindle by a set screw. The setting of this comb to the segments, also to the drawing-off rollers, either higher or lower, is done by a set screw on the fixed comb itself. This setting should be as close as possible without touching, both to the segments and to the drawing-off rollers. When the fixed comb has been set the machine should be turned by hand to see that nothing touches. The tension of the two springs which put pressure upon the nipper must also be watched so that the material may be properly held. The two springs which put pressure upon the drawing-off rollers must also be kept tight.

To the right and left of the framing of the machine are placed two stop screws whose object is to stop the drawing-off carriage. In order that the two above-mentioned springs may act, these two screws are tightened up.

When the rollers commence to grip the material at this moment there should be $\frac{1}{32}$ in. of play room between the lower roller and the segment, because if these organs touch, drawing-off could not take place. The drawing-off carriage should be set higher or lower according to the length of the fibre being combed. For long wools, the drawing-off rollers and segment should touch $\frac{1}{8}$ in. in front of the nipper; for medium wools $\frac{3}{4}$ in., and for short wools $\frac{3}{8}$ in.

If it is desired to set the traverse of the drawing-off rollers, two set screws placed behind the machine are used.

Another comb on the Heilmann principle called in Bradford the "French comb" is used to some extent for re-combing tops and for short fine wools such as South American. This comb has similar feed mechanism, comb cylinder, and fixed comb to the Schlumberger machine. The comb segment has ten rows of pins, and there is no drawing-off segment on the cylinder. The speed of the machine is very similar to that of the Schlumberger, but with the very important difference that the speed of the combing cylinder is irregular, being slowed down considerably while the comb segment pins are actually combing the fibre, and the cylinder is then speeded up again to make up for the slower motion. This motion is obtained by driving the comb cylinder from the main driving shaft through a series of three eccentric spur wheels, so that the speed is constantly changing from a maximum to a minimum and *vice versa*, being, of course, at a minimum when the combs are actually passing through the fibre. Drawing-off is accomplished by fluted rollers, between which is a leather apron, the arrangement being practically identical with that of the Delette machine previously described. The flutes in these drawing-off rollers are not straight across the length parallel to the axis, but are cut slightly spiral. By this means the rollers run steadier with less wear and tear upon the leathers. The upper

roller is usually of slightly smaller diameter than the lower one, there being usually an extra flute in the latter, so that the flutes are constantly changing relation with one another at the point of contact, and the small upper roller allows the top comb to come nearer to the nip, a point which is particularly important when short fibre is being combed. These fluted drawing-off rollers are of slightly greater diameter in the centre than at the ends, so that when pressure is applied at the ends and the ends sprung they may hold the fibre equally over their whole width.

CHAPTER VII.

THE ALISY-TRÜBENACH COMB.

The *Alisy-Trubenach Comb* is the latest thing in combs of the Heilmann type. It is the only double comb, and like the Delette machine has an oscillating comb circle. A general view is given of this comb in fig. 41, while fig. 42 shows an end section.

The oscillating comb circle has two comb segments with pins inclined in opposite directions. At each side of the circular comb are pairs of nippers, feed and drawing-off rollers. The machine works continuously, so that at each stroke combing takes place at one side and drawing-off at the other, the nippers oscillating and feeding alternately at each side rendering this possible. The circular combs are cleared by two circular brushes, and the noil from the doffers carried away in the form of a fleece by means of a dust roller and fan. The machine being double, the production is consequently double that of the ordinary Heilmann comb, while the floor space occupied is considerably less than would be occupied by two single combs. This machine has been such a short time on the market that we cannot say if it will become popular.

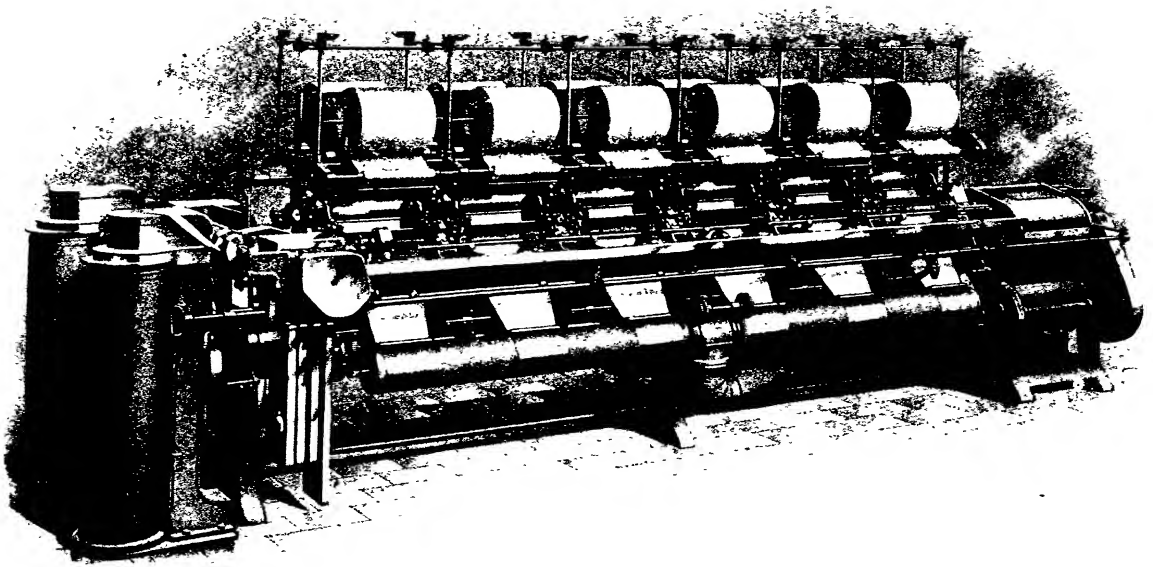


FIG. 41

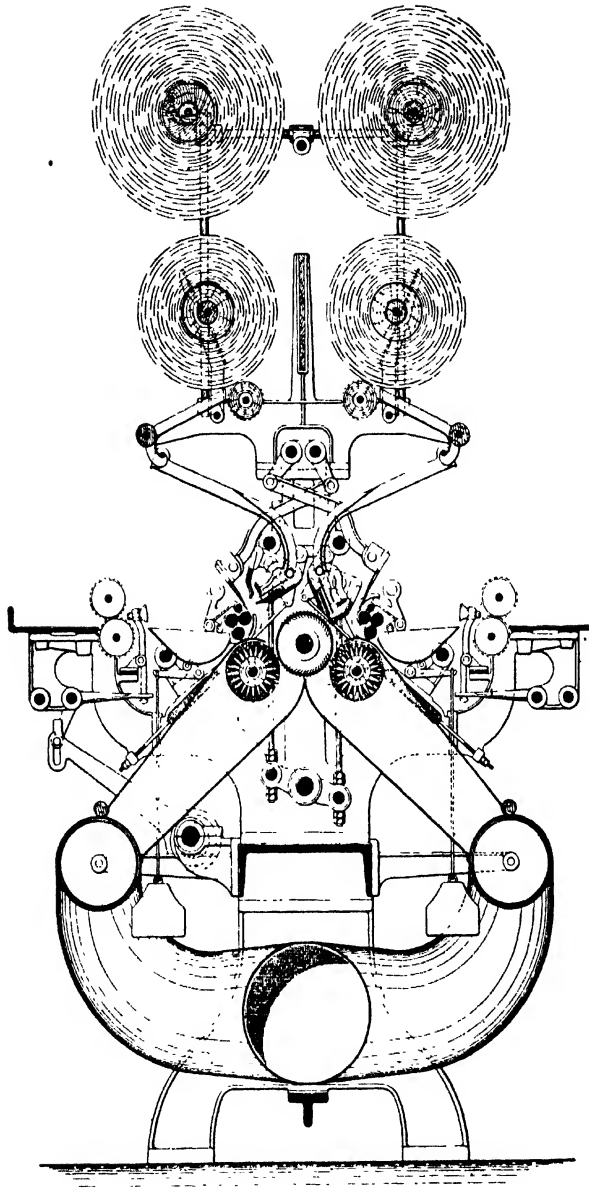


FIG. 42.

CHAPTER VIII.

THE LITTLE AND EASTWOOD COMB.

FIG. 43 gives a sectional view of the comb, which is suitable for short wool and cotton. As will be seen from the figure, the material to be combed passes from laps X, Y, and Z in a uniform fleece to the feed rollers W and V, and is pinned by the gills rising with the faller bars, as in a screw gill drawing or gill box, the fixed resistance bar A ensuring effective pinning. The gill head has a reciprocating motion upon horizontal slides, the front faller coming close up to the nipper 1. In the position shown in the figure the gills are about to recede, combing out one end of the tuft of wool held by the nipper jaws 1. When the gill head has travelled $1\frac{1}{4}$ in. backwards, a finger, corresponding with the scythe blade or sword of other combs, comes down between the gill and nipper and completes the pulling through of long fibres and separates the tuft. During this time the dabber brush C has been keeping the fibre well in the gill pins. The tuft having been separated, the cylinder moves round, a fresh nipper comes round, the gill head comes forward again, and the dabbing brush C rises so that the screws may revolve and carry forward the gill delivering the end of a fresh tuft into the nipper jaws and the cycle of operations repeats itself. When the nippers are carried round by the cylinder into the position of the nipper 5, the jaws slightly open, say about $\frac{1}{8}$ in., to relieve the wool of its pressure and to enable the dabbing brush D to place

the combed end of the tuft upon the pins of the comb circle T, as shown in connection with jaw 4. This jaw, on reaching position 4, opens to its extreme limit and remains open until it returns to position 1. The dabbing brush D, as shown, represents the second dab of the

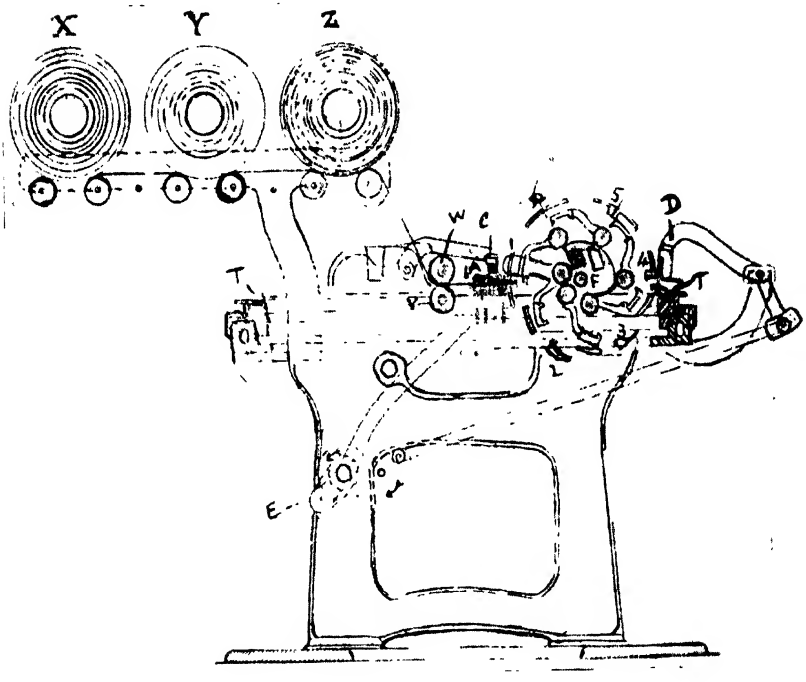


FIG. 43.

brush, it having already dabbed once, as seen by the fibre upon the circular comb T. The stroke of the dabbing brush can be regulated either for speed or lift of stroke. The position of the nipper cylinder, as shown in the figure, is as follows: The crank E is about to turn the

cylinder, and move the jaws onward as indicated by the arrow. The bottom of the faller pins is $\frac{7}{16}$ in. below the centre of the cylinder. The top of the inside row of pins in the circular comb in $\frac{1}{8}$ in. above the jaw, as shown at 4. Both the cams for opening and closing the jaws are fast to the shaft F, whilst the cylinder itself is free to revolve on the shaft F.

The circular comb T surrounds the machine. Drawing-off rollers catch the combed ends of the fibres as the circular comb carries them round and draws off the other end through its teeth so that both ends are combed and an endless sliver produced which is wound into a top. The noil is left in the pins of the comb circle, and is removed by plough knives and deposited in a can.

CHAPTER IX.

THE LISTER COMB.

ANOTHER nip comb working on a very similar principle is the Lister comb. Figs. 44 and 45 show its principal organs. The machine is in two parts, viz., a screw gill box, nip motion or reciprocating nipper D, carrying comb E, and comb circle C with drawing-off rollers. The fallers have not a reciprocating motion, as in the comb just described, the reciprocating nippers accomplishing the same object, viz., draw the fibres through the pins of the faller gills, and comb out one end of the tuft. In its forward position the nipper is met by the carrying comb made of long, thin wires, the points of which gently touch the nipper where the jaws come together. The nipper is caused to open at that moment, and as it recedes the carrying comb moves forward and passes on the fibres which it carries to the comb circle, into the pins of which a dabbing brush C^2 dabs the uncombed end of the tuft, and the carrying comb returns for another load. The comb circle revolves at a suitable speed, receiving regular supplies of wool, which is pulled away again by drawing-off rollers which, when the fibres are carried up to them, catch the combed and protruding ends and draw the other ends through and from the pins of the circular comb in which the noil is left. The drawing-off rollers revolve at a suitable speed to produce a continuous sliver of combed fibres, which have been combed first from the fallers, then from the carrying comb, and finally from the comb circle, issuing

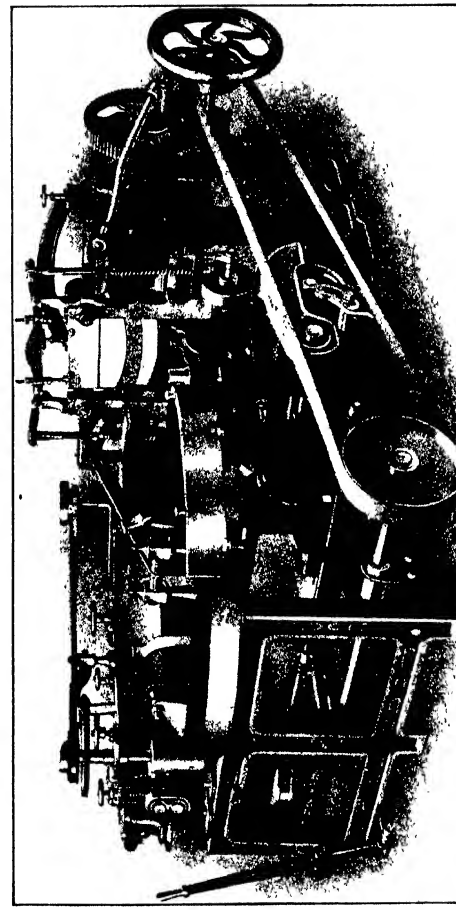


FIG. 44.

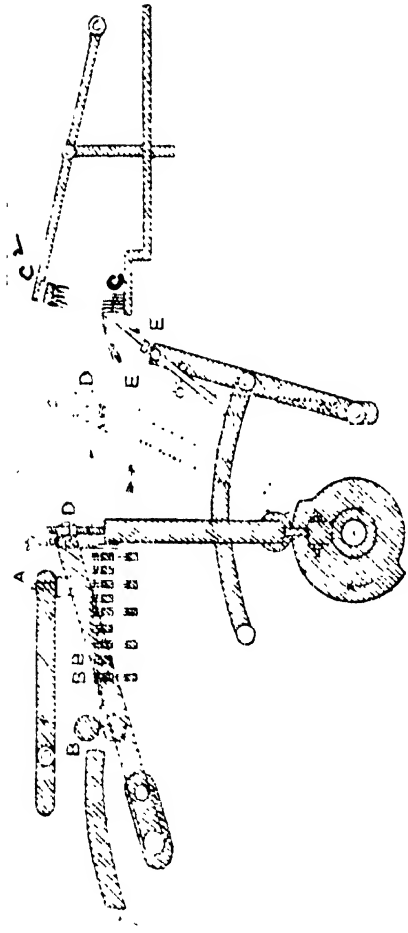


FIG. 45.

straight, parallel, and clean. The noil is cleared out of the circular comb pins by means of plough blades and falls into a receptacle or is drawn away by a suction pipe suitably placed. The comb circle is steam heated and a blast of air blows the combed ends forward so that they are caught by the drawing-off rollers. The gill box has no draft or front rollers. The back rollers merely feed the wool in, but do not hold it. The machine is usually fed from 30 cans of sliver. The fallers are gas heated and curved, being lower in the centre than at the ends, and have three rows of pins in each. There is a dabbing brush A above the fallers. The nip takes the place of the front rollers, and as the front faller drops into the bottom screw, the nipper moves up and closes on the tuft. The nipper corresponds in shape with the convex fallers. The drawing-off rollers are horizontal and tangentially set to the comb circle. From the drawing-off rollers the top is conducted by a leather apron to a revolving funnel, and thence to a coiler can. The comb circle is 48 in. in diameter, and is set with five rows of 2 in. pins, usually 20, 18, 16, 14, and 12 per inch, set over a width of $\frac{3}{4}$ in. The fallers are 20 in. long, and $\frac{1}{4}$ in. thick. There are three rows of pins in the gills, usually set 18, 16, and 15 per inch. The Lister comb is suited to combing long wool and hair, and especially mohair.

CHAPTER X.

THE HOLDEN COMB.

THE Holden or square-motion comb is another tuft comb very suitable for fine Botany wool, in which a fringe of uncombed tufts is fed on to a revolving circle. A square-motion combing head, consisting of a set of seven fallers, three up and four down, and *vice versa*, combs the exterior fringes, the tail end being combed as the combed fringe is drawn off by rollers and delivered in sliver as before. The uncombed slivers of wool are taken from balls or cans and pass half and half through two pairs of feed rollers working on two large eccentric wheels, which make them move backwards and forwards alternately so as to lash the wool on to the comb circle, a dabbing brush pressing it in as the rollers recede. The comb circle has two rows of pins, a fine row in front and a coarser one behind. A pressing-in knife works up and down over the comb circle quite close to the combing head. The pressing-in knife is a double plate of thin steel working up and down, one plate on either side of the front row of pins of the circular comb. It presses well on to the circle, with which it is carried forward, so as not to cut the wool. The fallers of the combing head are more than one inch wide and set with steel pins. The bars are straight at the ends, but concave in the centre to fit the circular comb against which they rise. The fallers rise at the rate of about 100 per minute, and, moving away, comb the end projecting from the circle. They are also provided with a dabbing brush. The gills are cleared of noil as the fallers drop by means of a little comb. Just before the drawing-off rollers grip the projecting fringe, a top or intersecting comb comes down just outside the circle.

CHAPTER XI.

THE NOBLE COMB.

THE Noble Comb is the one in almost universal use by the Bradford woolcombers and others for long and medium wool which has been "prepared," *i.e.*, made into slivers by means of a gill box and not carded.

A punch box or sliver lap machine is used to wind four slivers into a punch or ball, 18 of which are required to feed the comb, a general view of which is given in fig. 46. These 18 balls are placed in the circular rack which surrounds the machine, the ends being brought up through 72 feed boxes which are made of brass with a heavy lid, the back end being open, but the other end closed when empty. The lid is hinged at the back, so the whole weight of the lid falls upon the other end, and the slivers are consequently sufficiently firmly held to prevent their slipping backwards. Just inside the circle of feed boxes is the large comb circle and inside that again two smaller comb circles, one on either side. The large comb circle is usually 43 in. internal diameter and the small circles 16 in. external diameter. Eight to 11 concentric circular rows of pins stand up vertically on the large circle, their pitch varying, according to the quality of wool being combed, from 23 per inch in the first row, and 5 per inch on the last row, to 42 per inch and 14 per inch respectively, the latter being suited to 64's quality or Botany wool. The small circles have only 5 to 8 rows of pins upon them, and are

set from two to four pins per inch finer. The length of pin varies from $1\frac{3}{8}$ in. to $2\frac{1}{8}$ in., being rather shorter on the small circles. The set over or width of band of pins upon the large circles is from $1\frac{7}{8}$ in. for fine work to 4 in. for coarse work, the corresponding width set over upon the small circles being $\frac{5}{8}$ in. to $\frac{3}{4}$ in. In the finer rows, pins of flat section are used for strength, being set in the correct position to stand against the pull. These finer rows of pins are next the inside of the large circle and upon the outside of the small circles.

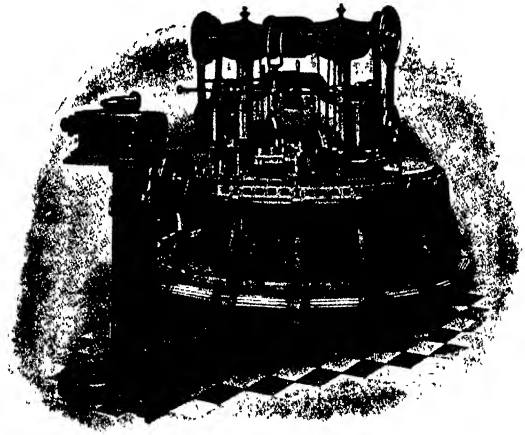


FIG. 46.

The large circle rests upon a circular steam chest to heat it, heat being necessary to make the fibres separate. The steam chest is stationary, but the large circle, feed boxes, and racks revolve together at a speed of from $3\frac{1}{2}$ to 4 revolutions per minute, usually upon ball bearings, by means of racks cut on the comb circle, there being 264 teeth on the rim of the large circle and 94 on the small circle, the surface speeds at the points of near approach of the circles being slightly in favour of the small circles. The three circles all move in the same direction, but the

small circles merely touch the larger at one point and revolving leave the latter behind. It is in this way that the wool is combed, for as the carriage carrying the feed boxes, racks, and large circle revolve, the wool is brought to the point of contact of the large circle and one of the smaller ones and forced into the pins by means of a rapidly reciprocating dabbing brush. The revolution of the circles effects the separation of the material, the long fibres being held and drawn away by that circle which has the greatest hold upon them, and the other circle combing out the protruding end which is left hanging like a fringe from the inside of the large circle or from the outside of a small circle. A rapidly revolving stroker wheel facilitates the separation of the wool between the two circles. The large circle having a larger number of rows of pins, practically all the long fibre is retained by it, the small circles taking the shorter fibre. Following the small circle as it revolves, we come to another stroker, a rapidly revolving wheel with sharp teeth which is set at the necessary angle to stroke the wool which projects from the little circle so as to turn the ends forward so that they may be caught by a small pair of vertical drawing-off rollers which seize the combed ends and draw the tail ends of the fibres through and out of the circle, leaving the noil behind to be cleared out by knives set between the rows of pins.

Fig. 47 shows these organs more distinctly, being in section with rack circles removed, showing also the ball bearings.

The drawing-off rollers are small and fluted. A leather runs round the larger or pressing roller, this leather having a traverse motion to minimize wear.

There are four sets of drawing-off rollers, one at each side of the large circle and one for each of the small circles. Four slivers are thus formed, being afterwards united in twos (on each side of the comb), and finally passed together through a revolving funnel situated in the

centre of the comb, between pressing rollers and into a can. No noil accumulates in the pins of the large circle,

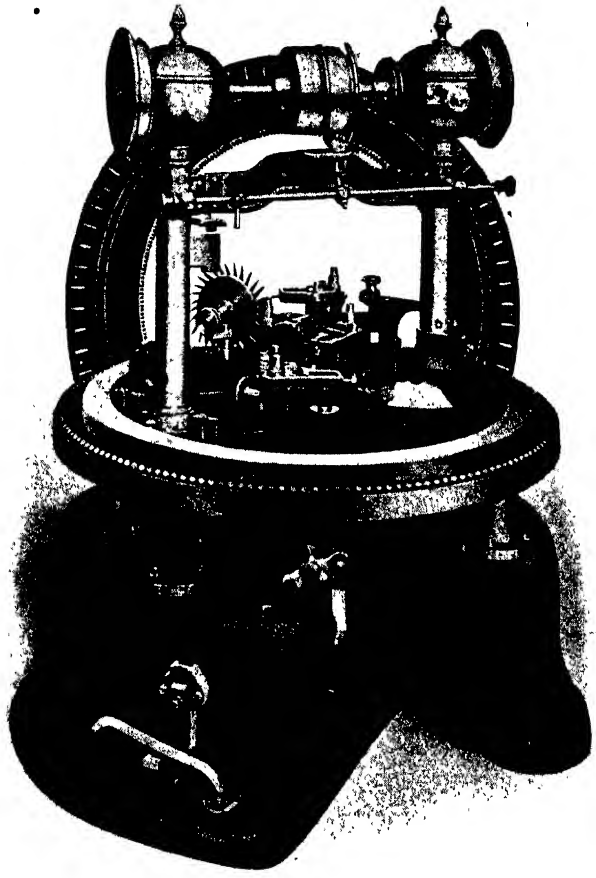


FIG. 47.

for every time the slivers are fed forward afresh the noil which may have been left by the fibres torn away by the

small circles and drawing-off rollers is carried forward and dabbed with the fresh fibres into the small circles, where it remains until removed by the "noil knives," as already described.

In feeding, the slivers are held by a presser knife while the feed boxes open and the sliver is drawn forward. The presser knives can be raised and lowered in the pins so that the length fed forward is more or less. The further the slivers are drawn forward the more noil is made. The ends are again lifted from the pins by fixed knives. The dabbing brushes make as many as 1,200 dabs per minute. One defect of the Noble comb is that a small portion of the sliver which is dabbed between the circles never gets combed at all, and may contain noil, knots, &c.

The percentage of noil from the Noble comb on scoured wool varies from 6 per cent. for long lustre English wool to 20 per cent. on some South American, and from greasy wool from 40 per cent. on long lustre English to 64 per cent. on average Australian merino. The noil may be worth 1s. 3d. per lb. In wool combing "tear" represents the proportion of top to noil, say, 8:1. The floor space occupied by the Noble comb is about 70 square ft., and the power required 3 to 4 h.p.

A recent modification of the Noble comb (a Bradford invention) consists in the introduction of a third small circle, making four circles altogether, and results in increased production. In this comb revolving discs with saw tooth edges are used instead of dabbing brushes, with the result that there is less vibration and a saving in power. The old top gearing is also done away with, making it easier to change the circles.

CHAPTER XII.

THE PREPARATION OF THE MATERIAL FOR COMBING.

Except in the case of long wool, hair and ramie, which are slivered upon a sheeter or spreader with rollers and gills, all the remaining fibres that are combed, *i.e.*, cotton, silk, and ramie noils, short wool and hair, flax tow, &c., are first carded. In order that the maximum gross yield of combed sliver may result, the card should be used rather as a sliver former than as a cleaning machine, for the reason that if used in the ordinary way, the tow card, for instance, will drop into the wastepit a great many medium length fibres, which, if they can be carried through the card, will, when combed, be a welcome addition as increasing the yield of combed fibre and reducing the cost of the combed sliver or top. For such fibre it is sufficient then to employ a coarse finisher card with short draft and large cylinder pinion, running the material quickly and in bulk through the card. The passage of the sliver through a gill or roller drawing head helps to render the fibres straighter and more parallel, a most important condition if the maximum yield of combed fibres is to be obtained later. So important is it to get the fibres straight and parallel before attempting to comb them, that it will well repay the cost of labour and time expended in giving the carded slivers a drafting and doubling over at least one drawing and doubling frame

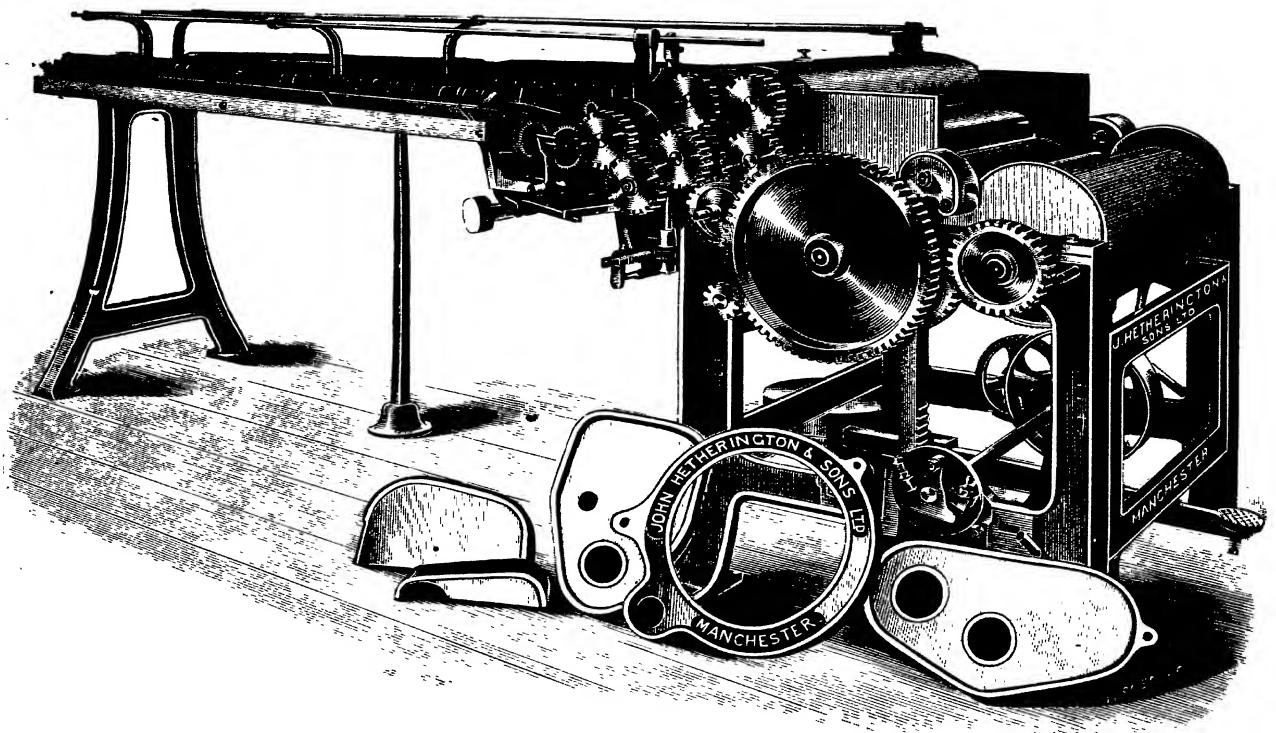

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FIG. 48.

before putting them up at the comb. The usual procedure in preparing cotton sliver for combing is to unite a given number of carded slivers into a sheet and form them into a lap upon a Derby doubler, as shown in fig. 48. The heavy laps formed by this machine are afterwards put up on the ribbon lap machine, drawn out, doubled together and formed into another lap to feed the combing machine.

The Derby doubler, fig. 48, is fed by from 22 to 72 cans of sliver from the card. These cans are arranged along the V-shaped table shown, and the slivers drawn from them passed over the usual stop motion spoon lever guides, and are arranged in parallel order and formed into laps 10 in. to 13 in. wide.

The ribbon lap machine, fig. 49, usually takes six laps from the previous machine. This machine has usually four pairs of rollers which draw out and straighten the fibres, which, as we have already stated, assists the comber in doing its work, and keeps down the quantity of noil. The cotton comber takes laps from 7½ in. to 10½ in. in width, for the usual Heilmann comb these laps weighing at the rate of 15 yd. per oz. per inch in width. The Nasmith comber takes a much heavier lap, as much as 5 yd. per oz. per inch in width.

Sometimes the sliver lap machine is used instead of the Derby doubler to prepare laps for the ribbon lap machine, and sometimes the ribbon lap machine is not employed at all, the slivers from the card being put through one head of drawings and then through the sliver lap machine, the laps made thereon being taken direct to the comber.

The sliver lap machine (fig. 50) is fed with from 14 to 20 cans of sliver placed behind the machine. The slivers are drawn out by three lines of rollers and rolled into a lap, the draft of the machine being usually two.

A combined draw frame and lap machine is also sometimes used in place of the sliver lap and ribbon lap machine

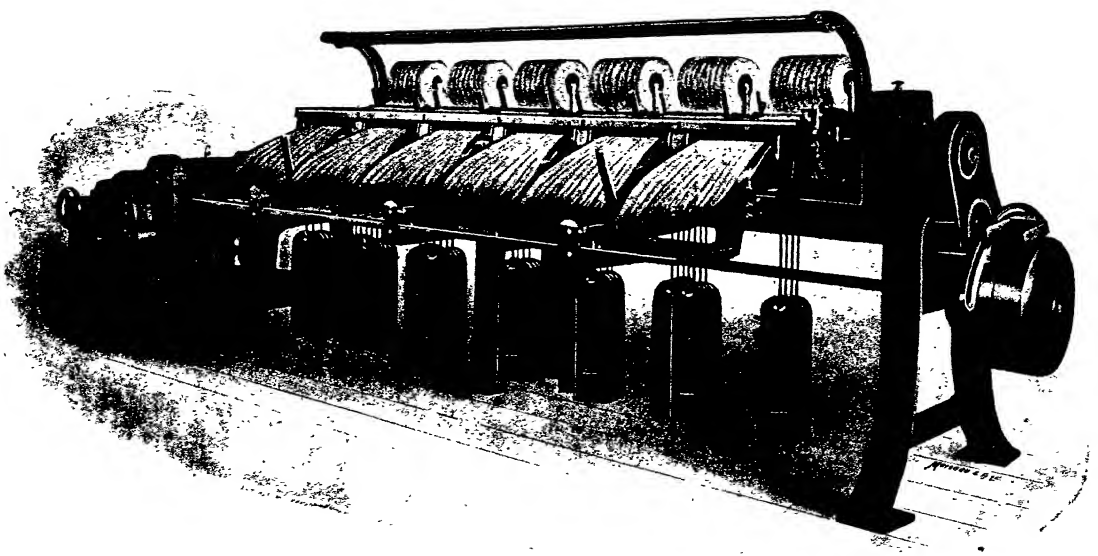
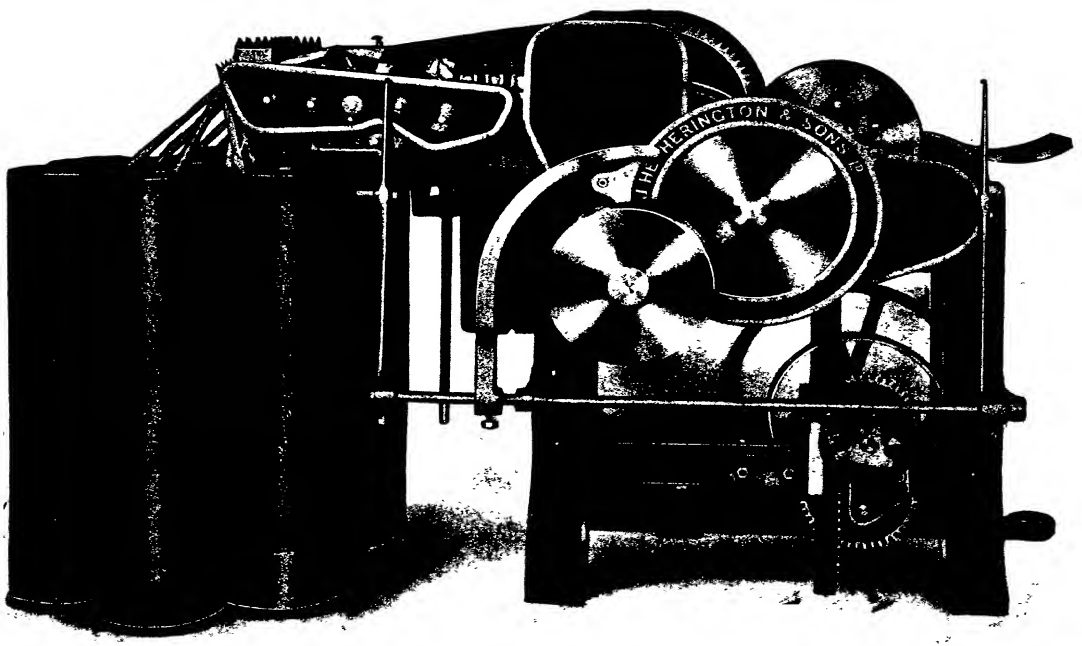


FIG. 49.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to make comber laps direct from card sliver. This is usually a three- or four-headed machine, fed by from 12 to 16 cans per head. After being drawn out by four lines of rollers all the slivers are combined and formed into a lap for the comber.

When cotton is combed twice after the first combing the sliver passes again to the sliver lap machine and ribbon lap machine to the second comber, or to a draw frame and sliver lap machine to the second comber.

Laps of wool and flax tow are also sometimes prepared to feed Delette, Schlumberger, and similar combers upon a combined gill box and lap machine, to ensure a straight feeding of the fibres into the comb; combing, as we have said, being rendered easier by a uniformly thick feed or equal distribution of the fibres between the nipper jaws.

Flax tow combs are usually fed by slivers from the first drawing frame, slivers to the number of either 15 or 8 being put up at the back. Some spinners prefer to feed with 8 heavy slivers instead of the 15 lighter ones. The weight of the slivers should be altogether from 210 lb. to 240 lb. per set of 500 yd. cans. That is to say, when working with 15 cans per set the weight of each 500 yd. can should be from 14 lb. to 16 lb., and when working with only 8 cans per set the weight of each 500 yd. can should be from 26 lb. to 30 lb. On the whole we believe that 15 cans gives the levelest feed across the whole width of the machine and consequently the best results.

The "Punch Box," fig. 51, is used to ball or wind four prepared or backwashed wool slivers parallel into a roll, about 18 in. in diameter and 20 lb. weight, for the Noble comb.

The percentage of noil produced by the combing machine is easily calculated as follows: Multiply the weight of the noil produced in a given time by 100 and divide this produce by the weight of combed sliver produced in the same time plus the weight of the noil. Thus, if in a short time a cotton comber produces 15 grains of

waste or noil and 58 grains of combed sliver, the percentage of waste or noil is

$$\frac{100 \times 15}{15 + 58} = \frac{1500}{73} = 20{\cdot}5 \text{ per cent.}$$

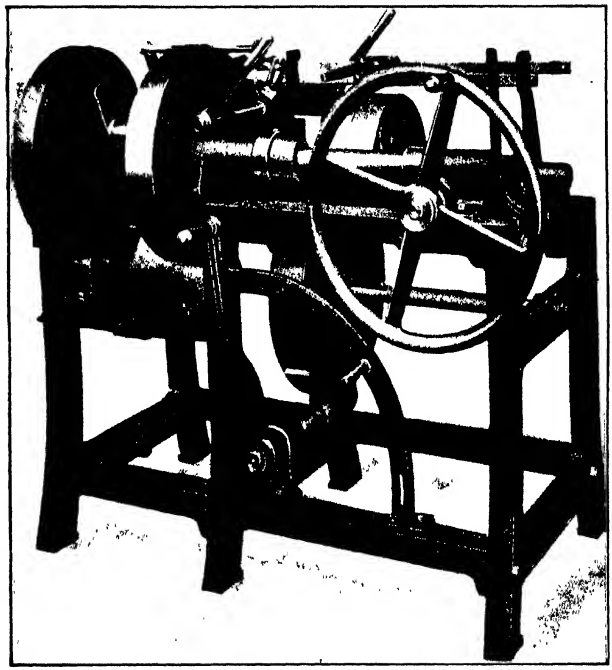

FIG. 51.

In wool combing instead of stating the percentage of noil, one speaks of the "tear," meaning the proportion of top to noil, say 8 : 1.

To show the method of costing the combed sliver we will take an example from the worsted trade as being the

most complicated, the costing of combed cotton or flax tow being a simpler operation performed on similar lines. Suppose 60 packs of wool each weighing 240 lb. = 14,400 lb. of English long lustre are taken, scoured, carded and combed with the result that there result 6,300 lb. of top, 630 lb. of noil, 48 lb. of shoddy, and 42 lb. of burrs, there being 7,380 lb. of sinkage. The "tear" or proportion of top to noil is evidently 10:1. The sinkage, which comprises dirt, grease and fly, is, of course, absolute loss. The burrs taken out by the card and the shoddy or waste produced during carding are only worth, say, 1d. or 2d. per lb. respectively, and their value may be neglected to keep one on the safe side. The noil, however, is worth, say, 1s. 3d. per lb., or 15 × 630 = 9,450d. The cost of combing may be taken at the rate of 2¼d. per lb. of top, so that we have first, 14,400 lb. of wool at, say, 1s. 4d. per lb., value £957 12s. Deduct 630 lb. of noil at 1s. 3d., value £39 7s. 6d., and we get £918 4s. 6d. Add the cost of combing 6,300 lb. at 2¼d. per lb., or £59 1s. 3d., and we get £977 5s. 9d., which is the actual cost of 6,300 lb. of top, or 37·2d. per lb.

APPENDIX.

THE following interesting facts relating to combing have been extracted from a recently published American Blue Book or report: In England, while the Heilmann comber is largely used for cotton, the Noble comber is usually used for worsteds. In France all makes of combs are employed—the Lister or nip comb (for long wool only), the square motion Holden comb (in Holden's works), the Noble, the Offerman, the Delette, &c. The bulk are of the Heilmann type, as they are specially suited to French work and for short staple. Most French combing is dry, *i.e.*, the fibres are not oiled. The making of tops is a great branch of the woollen industry in France, the mills in this line doing nothing else, and not only supplying their home spinning mills, but exporting largely. One of the most up-to-date and largest firms in Roubaix is that of Alfred Motte and Co. In their separate combing mill there were in operation in 1908 150 Offerman Ziegler combs, 72 Lister combs, and 42 Noble combs. Their yearly production of tops is about 12,000 tons. Usually 70 per cent. are La Plata wools, 15 per cent. Australian and New Zealand, 5 per cent. French and Algerian, and the remainder South African, Chilian and Spanish.

About 1,600 tons is washed for export, going to England, Germany, and Russia. Two thousand hands are employed by Messrs. Motte. Their wool sorters sort from 300 lb. to 400 lb. per day and earn about 5d., per hour.

There are nearly 3,000 wool combs in Great Britain,

all except about 300 being located in Yorkshire. Combing on commission is not such a large business in England as in France and Belgium. The bulk of the mills who did combing on commission have been bought up and amalgamated into one company called Wool Combers Ltd., of Bradford. This company owns 23 branch mills each containing from 8 to 34 combs, with a total of 434. These are practically all Noble combs.

Woolcombers' prices are approximately from 3d. to 5½d. per lb. For China and Russian camels' hair from 3¾d. to 6d. per lb. is charged, and from 3d. to 4d. for alpaca and mohair.

Repairing the Combs.

Besides the renewal of tappets or cams, friction rollers, leather sheets, &c., which are subject to considerable wear and the turning up of drawing-off segments, the pins of the comb circles, fallers, comb slips, and fixed combs require frequent repairs, being broken out by loops, knots, &c., in the sliver. Repairs are effected to the comb circles and fallers by breaking out defective pins with a pair of pliers, and driving out the stumps in the reverse direction to that in which they were driven into the brass stock, and filling in the holes again with fresh pins of suitable length and wire gauge.

The comb slips and fixed or top combs of combers of the Heilmann type are formed by soldering the bases of the pins side by side on to the brass or steel slips which are screwed to the comb segment or top comb arms. In order that these pins may be properly spaced, the top end of the pins to be inserted are clamped in what is known as a book, French "*moule*," the jaws of which are grooved to a suitable length and depth to hold the pins in their proper positions, points in a straight line and correctly spaced, so many per inch. When full of pins, the book is applied parallel to the strip edge, the

butts of the pins overlapping the slip by the correct amount, and then the solder applied smoothly with an iron, in sufficient quantity to firmly attach the pins to the slip. When firm, the brass book may be removed. If only a few pins are broken out, it is unnecessary to unsolder the whole row if a short repair book is used and the end holes employed as guides on the good pins at each extremity of the gap, so that the new pins may join up properly with the old and not leave too wide a space through which naps may escape.

As the necessary apparatus for comb repairing costs more money than many combers care to pay for the privilege of making their own repairs, firms can keep a few spare sets and have their repairs done outside by firms who make a speciality of this work, such as Mr. F. H. Bentham, Richmond Road, Bradford.

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